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JAN 82 R RIGGINS, E HERRICKS, M J SALE DACA88-78-R-006
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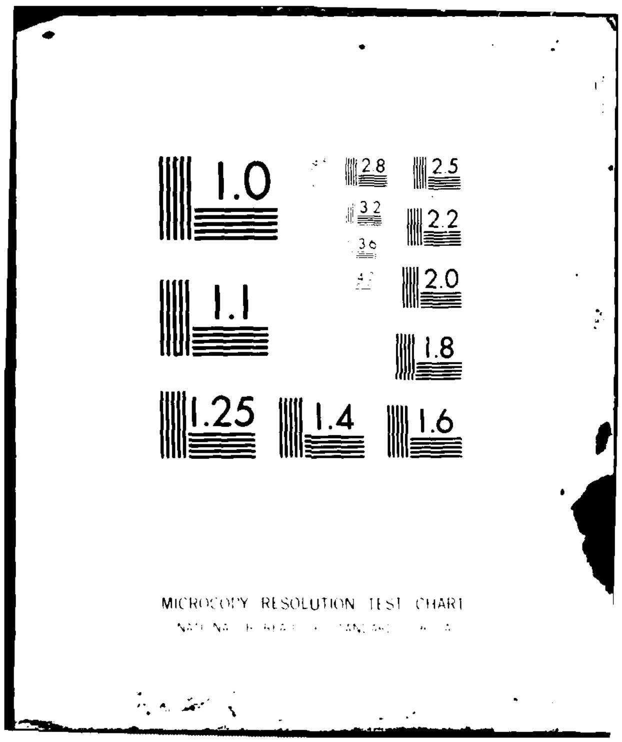
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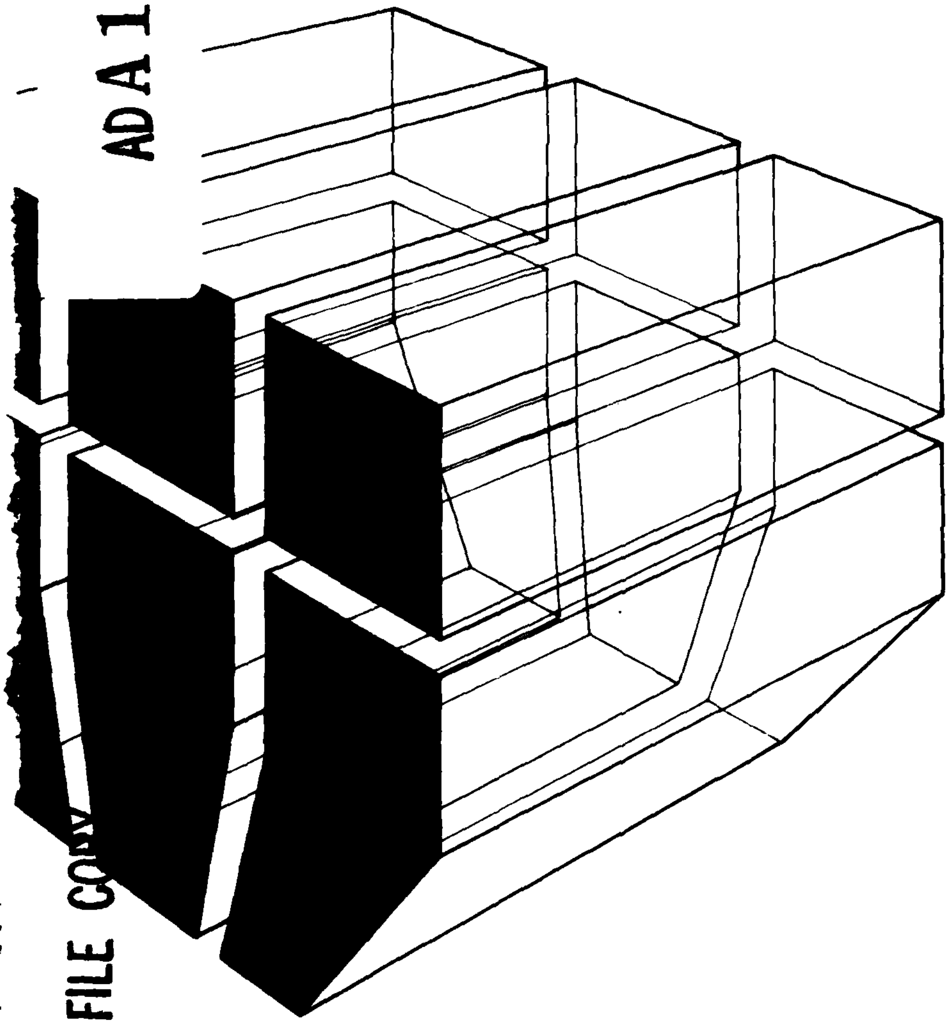
Technical Report N-114
December 1981
Water Quality Model System

QUANTITATIVE ASSESSMENT OF ENVIRONMENTAL IMPACTS IN THE AQUATIC ENVIRONMENT



by
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This report describes the development of a rigorous set of analysis procedures useful for identifying significant effects resulting from Army activities on aquatic ecosystems. Application guidelines and examples of these procedures are provided. The analysis procedures include techniques for organizing pertinent environmental information, simulation of spatial and temporal variations in water quality, and prediction of impact significance.

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FOREWORD

This study was performed for the Directorate of Military Programs, Office of the Chief of Engineers (OCE) under Project 4A762720A896, "Environmental Quality for Construction and Operation of Military Facilities"; Task A, "Environmental Impact Monitoring, Management, Assessment, and Planning"; Work Unit 022, "Water Quality Model System." The work was performed by personnel in the Civil Engineering Department of the University of Illinois, under Contract DACA 88-78-R-006, for the Environmental Division (EN) of the U.S. Army Construction Engineering Research Laboratory (CERL). Mr. Paul Carmichael, DAEN-MPE-T, was the OCE Technical Monitor.

The work was performed by the Environmental (EN) Division of the U.S. Army Construction Engineering Research Laboratory (CERL). Mr. R. E. Riggins was the CERL Principal Investigator. Dr. R. K. Jain is Chief of CERL-EN.

COL Louis J. Circeo is Commander and Director of CERL, and Dr. L. R. Shaffer is Technical Director.

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QUANTITATIVE ASSESSMENT OF ENVIRONMENTAL IMPACTS IN THE AQUATIC ENVIRONMENT

1 INTRODUCTION

Background

During the first decade of legislated environmental assessment of governmental activities, there have been changes in approaches and attitudes toward the National Environmental Policy Act (NEPA), as well as implementation of new legislation and administrative guidelines requiring new forms of environmental planning. New terminology, such as "scoping," "fate and effect," "hazard evaluation," etc., has appeared, and new methodologies have been developed for environmental planning and management. Unfortunately, legislative acts and rhetoric tend to grow faster than do the tools to carry them out. As a result, quantifying and measuring the significance of environmental impacts still remains an elusive target during planning, and flexible and efficient tools are needed to predict, evaluate, and mitigate these impacts. To meet this need, the U.S. Army Construction Engineering Research Laboratory (CERL) has developed a prototype package of computerized impact evaluation procedures called the Rational Impact Assessment System (RIAS) which use site-specific quantification routines to answer such questions as, "How bad will the impact be?" or "Will the impact be significant?"

Objective

The objective of this report is to document the development of RIAS as an impact evaluation tool.

Approach

Because the mechanisms of environmental impacts can be extremely complex and varied, it is difficult to construct one comprehensive simulation tool for predicting them. For this reason, the computer software developed to support RIAS consists of a series of independent modules which can be used either as separate programs or together as subroutines within a larger control program. The number of modules used depends entirely on the decision-maker's needs and the types of impacts identified through initial scoping.

Data collection, processing, and impact simulation carried out in RIAS proceed through the use of three general procedures: Filter Questions (FQUES), Water Quality Simulation (SIMWQ), and Rational Threshold Value Test (RTVTEST) (see Figure 1). Appendix C provides program listings for these three systems. FQUES collects and organizes relevant environmental setting and project information data through a computerized format of filter questions. SIMWQ simulates primary impacts on the physical/chemical attributes of

the aquatic receiving system over both temporal and spatial dimensions. RTVTEST is a set of rational threshold values (RTV) models which predict the significance of the primary and secondary impacts listed by SIMWQ. This series of analyses simulates the impact chain of events and provides a uniform method for environmental data handling.

Chapters 2 and 3 document the development of RIAS as an impact significance evaluation tool, describing these three supporting modules and providing user information for application of RIAS to the quantitative assessment of impacts on aquatic ecosystems. Four example applications of RIAS (Chapter 4) and user information for data collection and organization are presented (Chapter 5).

Mode of Technology Transfer

The information in this report will be issued as a DA Pamphlet in the 200 series and as the module called RIAS in the remote terminal ADP system entitled Environmental Technical Information System (ETIS).

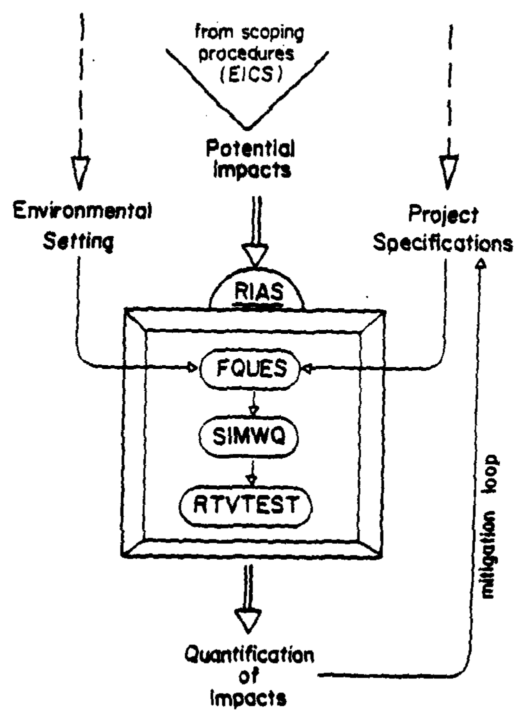

Figure 1. General design and information flow for the RIAS.

2 FILTER QUESTIONS

FQUES has been developed to execute a program which asks a series of questions about a specific project's environmental setting and organizes the information obtained into a data file. The data file is then used as input for simulations and other evaluation protocols.

FQUES can be used to set up a new data file or to revise an existing data file. Output from FQUES stores data related to such things as number of stream reaches, number of conservative and nonconservative water quality attributes, tributary inputs, point source discharges, hydraulic rating parameters, boundary conditions, and biological parameters.

3 WATER QUALITY SIMULATIONS (SIMWQ)

The development of SIMWQ has been restricted to one-dimensional, non-dispersive, steady-state, plug flow models for receiving streams. Whenever possible, rate equations have been limited to first-order reaction kinetics. This results in linear rate equations which provide analytical solutions. In addition, it avoids the necessity of using complicated numerical solution techniques for sets of differential equations and produces a much more usable model.

SIMWQ considers two types of sources or sinks for water quality constituents. First-order decay or accumulation terms, similar to the form of the Streeter-Phelps equation, are used to represent most biological activity in the stream. These terms can also be used for distributed sources or sinks which affect the stream equally along a longitudinal gradient. Examples of these terms are benthic oxygen demand or nonpoint source runoff. The receiving watershed is represented by a series of stream reaches within which all model parameters are constant. At the end of each reach, new model parameters are calculated, based on local environmental data and point source inputs. These results are combined with upstream values based on conservation of mass and assuming complete mix. This modeling approach is not new; however, it is an efficient, flexible system for tracing changes in water quality.

One major addition to the computer program which is the basis for SIMWQ is the capability to handle branched watersheds. This required coding the boundary conditions for reaches rather than a modification of the analytical solutions.

Figure 2 shows the general conceptual design of SIMWQ and the variables it can analyze. Tables 1 and 2 define the model's variables and parameters, respectively. Table 3 presents the rate equations which represent the heart of the model. Table 4 lists the analytical solutions derived from the equations provided in Table 3. These solutions assume time-constant model parameters and apply only within reaches. Tributaries and any applicable point source inputs between reaches are accounted for by Eq 1:

$$C = \frac{Q_1C_1 + Q_2C_2}{Q_1 + Q_2} \qquad \text{[Eq 1*]}$$

where C denotes concentration, Q is flow, and subscripts 1 and 2 refer to the different flows being combined.

Several simplifying assumptions were used to reduce the system of rate equations to the desired forms, including:

1. Algae concentrations will be relatively constant for a given reach and a given season of the year.

2. Higher organisms, such as fish and invertebrates, do not significantly affect the rate of concentration change for any of the attributes considered.

---

*Variables for all equations in text are defined in Table 2.

3. For the purpose of SIMWQ, certain water quality attributes can effectively be considered conservative substances (e.g., TDS, hardness, pH, total alkalinity).

These, and other assumptions involved with steady-state and nondispersive models, must be reevaluated in each application of SIMWQ.

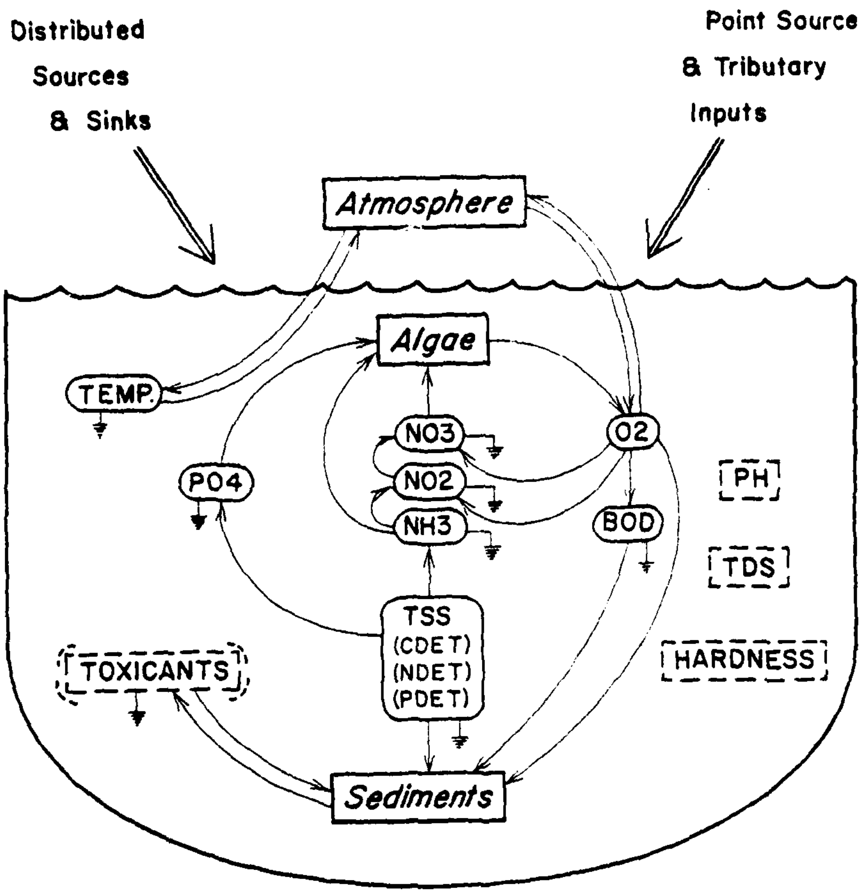

Figure 2. Conceptual organization of interactions between water quality attributes within each stream reach in SIMWQ.

Table 1

SIMWQ Variable Listing

Symbol	Definition	Units
ALK	Total alkalinity as $CaCO_3$	mg/ℓ
C	Total dissolved inorganic carbon	mg/ℓ
CDET	Carbon content of detritus in water column	mg/ℓ
CO2	Dissolved carbon dioxide	mg/ℓ
COLI	Coliform bacteria concentration	#/100 mℓ
CONSi	i^{th} additional conservative water quality constituent	mg/ℓ
D	Dissolved oxygen saturation deficit	mg/ℓ
HARD	Water hardness as $CaCO_3$	mg/ℓ
L^i	Biochemical oxygen demand (BOD_5)	mg/ℓ
NCONi	i^{th} additional nonconservative water quality constituent	mg/ℓ
NDET	Nitrogen content of detritus	mg/ℓ
NH3	Total ammonia nitrogen	mg/ℓ
NO2	Nitrite nitrogen	mg/ℓ
NO3	Nitrate nitrogen	mg/ℓ
O2	Dissolved oxygen	mg/ℓ
PDET	Phosphorus content of detritus	mg/ℓ
pH	pH of surface water ($-\log_{10} [H^+]$)	--
PO4	Phosphate-phosphorus	mg/ℓ
TW	Temperature of water	^oC
TSS	Total suspended solids	mg/ℓ
TDS	Total dissolved solids	mg/ℓ

Table 2

SIMWQ Parameter Listing

Symbol	Definition	Values	Sources*
1. Distributed Sources/Sinks			
S_L	Scour/runoff of BOD_5		
S_{NCONi}	Nonpoint sources of non-conservative pollutants		
S_{NH3}	Surface runoff of NH_3		
S_{NO3}	Surface runoff of NO_3		
S_{O2}	Daily mean net 1^o production		
S_{PO4}	Surface runoff of PO_4		
S_{SOD}	Sediment oxygen demand		
S_{SS}	Scour/erosional inputs of suspended solids		
S_T	Natural heat inputs from atmosphere		
2. Reaction Rates $(K_i^T = \Theta_i^{T-2} \cdot K_i^{20^oC})$			
k_{ANH3}^T	Algal uptake of NH_3	0.1 to 4.0	
k_{ANO3}^T	Algal uptake of NO_3	0.1 to 4.0	White & Dracup
k_{APO4}^T	Algal uptake of PO_4	0.005 to 0.5	White & Dracup
k_L^T	Decomposition of BOD_5	0.01 to 2.5	HEC, Zison
k_{LS}^T	Bottom exchange of BOD_5	0.0 to 2.0	

*See References, pp 32-33.

Table 2 (Cont'd)

Symbol	Definition	Values	Sources*
k^T_{NCONi}	Biodegradation/decay of ith nonconservative pollutant	attribute dependent	
k^T_{NDET}	Mineralization/dissolution of nitrogen portion of detritus	0.001 to 0.02	HEC
k^T_{NH3}	Microbial conversion of NH_3	0.01 to 2.5	Zison, pp 188-197 HEC
k^T_{NO2}	Microbial conversion of NO_2	0.020 to 0.5 0 to 10.0	Miller & Jennings White & Dracup HEC
k^T_{NO3}	Microbial conversion of NO_3	≈ 0.001	Miller & Jennings
k^T_{PDET}	Mineralization/dissolution of phosphorus portion of detritus	0.001 to 0.02	HEC
k^T_{PO4}	Decay of phosphates due to microbial uptake/conversion	(0.01) 0.005 to 0.5	White & Dracup
k^T_R	Reaeration of dissolved oxygen	$k^{20}_R = a\ U^b\ H^c$	Covar
k^T_{SS}	Decay of suspended solids (mineralization/biotic breakdown)	0.001 to 0.02	HEC
k^T_{SSS}	Settling of suspended solids	0 to 2.0	HEC

*See References pp 32, 33.

Table 2 (Cont'd)

Symbol	Definition	Values	Sources*
k_T	Heat exchange with atmosphere	(See Temp. Model in the Computer Listing)	
k^T_{TSS}	Overall decay of suspended solids $(k^T_{TSS} = k^T_{SS} + k^T_{SSS}/\text{depth})$	$k^T_{SS} + k^T_{SSS}/\text{depth}$	

*See References pp 32, 33.

Table 3

SIMWQ Rate Equations*

Rate Equations (within reaches, excluding point sources)

1. Temperature

$$\frac{dT}{dt} = S_T - k_T \; T_t$$

2. BOD

$$\frac{dL}{dt} = -(k_L^T + k_{LS}^T) \; L_t + S_L$$

3. Suspended Solids

$$\frac{dTSS}{dt} = -k_{TSS}^T \cdot TSS_t + S_{SS} = -(k_{SS}^T + \frac{k_{SSS}^T}{depth}) \; TSS_t + S_{SS}$$

4. Phosphate-Phosphorus

$$\frac{dPO4}{dt} = -k_{PO4}^T \cdot PO4_t + k_{PDET}^T \cdot PDET_t + S_{PO4} + k_{APO4}^T \cdot A$$

5. Ammonia-Nitrogen

$$\frac{dNH3}{dt} = -k_{NH3}^T \cdot NH3_t + k_{NDET}^T \cdot NDET_t + S_{NH3} + k_{ANH3}^T \cdot A$$

6. Nitrite-Nitrogen

$$\frac{dNO2}{dt} = -k_{NO2}^T \cdot NO2_t + k_{NH3}^T \cdot NH3_t$$

---

* Equation variables are defined in Table 2.

Table 3 (Cont'd)

7. Nitrate-Nitrogen

$$\frac{dNO3}{dt} = k_{NO2}^{T} \cdot NO2_{t} - k_{NO3}^{T} \cdot NO3 + S_{NO3} + k_{ANO3}^{T} \cdot A$$

8. Dissolved Oxygen Deficit

$$\frac{dD}{dt} = -k_{L}^{T} \cdot L_{t} + k_{NH3}^{T} \cdot L_{t}^{NH3} + k_{NO2}^{T} \cdot L_{t}^{NO2} - k_{R}^{T} D_{t} - S_{O2} + S_{SOD}$$

9. Conservative Constituents

$$\frac{dCONi}{dt} = 0$$

10. Nonconservative Constituents

$$\frac{dNCONi}{dt} = -k_{NCONi}^{T} \cdot NCONi + S_{NCONi}$$

Table 4

Analytical Solutions to Table 3*
(These equations apply only within stream reaches which have constant model parameters.)

---

1. Biochemical Oxygen Demand (L)

$$L_t = (L_0 - \underline{\bar{K}}_1^{L})\exp(-(k_L^T + k_{LS}^T)t) + \underline{\bar{K}}_1^{L}$$

$$\text{where } \underline{\bar{K}}_1^{L} = \frac{S_L}{(k_L^T + k_{LS}^T)}$$

2. Total Dissolved Solids (TSS)

$$TSS_t = (TSS_0 - \underline{\bar{K}}_1^{TSS})\exp\left(-\left(k_{SS}^T + \frac{k_{SSS}^T}{depth}\right)t\right) + \underline{\bar{K}}_1^{TSS}$$

$$\text{where } \underline{\bar{K}}_1^{TSS} = \frac{S_{SS}}{(k_{SS}^T + k_{SS}^T + k_{SSS}^T depth)}$$

3. Suspended Solids Portioning

$$CDET_t = PC(TSS_t)$$

$$NDET_t = PN(TSS_t)$$

$$PDET_t = PP(TSS_t)$$

4. NH3

$$NH3_t = (NH3_0 - \underline{\bar{K}}_1^{n} - \underline{\bar{K}}_2^{n})\exp(-k_{NH3}^T t) + \underline{\bar{K}}_1^{n}\exp(-k_{SS}^T t) + \underline{\bar{K}}_2^{n}$$

---

* Equation variables are defined in Table 2.

Table 4 (Cont'd)

$$\text{where} \quad \underline{K}_1^{n} = \frac{[k_{NDET}^{T} \cdot PN(TSS_o - \underline{K}_1^{TSS})]}{(k_{NH3}^{T} - k_{SS}^{T})}$$

$$\underline{K}_2^{n} = (k_{NDET}^{T} \cdot PN \cdot \underline{K}_1^{TSS} + S_{NH3} - k_{ANH3}A)/k_{NH3}^{T}$$

5. NO2

$$NO2_t = (NO2_o - \underline{N}_1 - \underline{N}_2 - \underline{N}_3)\exp(-k_{NO2}^{T}t) + \underline{N}_1 \exp(-k_{NH3}^{T}t)$$

$$+ \underline{N}_2 \exp(-k_{SS}^{T}t) + \underline{N}_3$$

$$\text{where} \quad \underline{N}_1 = \frac{k_{NH3}^{T}\,(NH3_o - \underline{K}_1^{n} - \underline{K}_2^{n})}{k_{NO2}^{T} - k_{NH3}^{T}}$$

$$\underline{N}_2 = \frac{k_{NH3}^{T}\,\underline{K}_1^{n}}{k_{NO2}^{T} - k_{SS}^{T}}$$

$$\underline{N}_3 = \frac{k_{NH3}^{T}\,\underline{K}_2^{n}}{k_{NO2}^{T}}$$

6. NO3

$$NO3_t = NO3_o + \underline{K}_1^{no} - \underline{K}_2^{no}\exp(-k_{NO2}^{T}t) - \underline{K}_3^{no}\exp(-k_{NH3}^{T}t) - \underline{K}_4^{no}\exp(-k_{SS}^{T}t)$$

where $\underline{K}_1^{no} = (k_{NO2}^T \, \underline{N}_3 + S_{NO3} - k_{ANO3}^T \, A)t$

$$\underline{K}_2^{no} = NO2_o - \underline{N}_1 - \underline{N}_2 - \underline{N}_3$$

$$\underline{K}_3^{no} = \frac{k_{NO2}^T}{k_{NH3}^t} \underline{N}_1$$

$$\underline{K}_4^{no} = \frac{k_{NO2}^T}{k_{SS}^T} \underline{N}_2$$

7. PO4

$$PO4_t = (PO4_o - \underline{K}_1^p - \underline{K}_2^p) \exp(-k_{PO4}^T t) + \underline{K}_1^p \exp(-k_{SS}^T t) + \underline{K}_2^p$$

where $\underline{K}_1^p = \dfrac{k_{PDET}^T \, (PP(T_{SS_o} - \underline{K}_1^{TSS}))}{k_{PO4}^T - k_{SS}^T}$

$$\underline{K}_2^p = \frac{k_{PO4}^T \cdot PP \cdot \underline{K}_1^{TSS} + S_{PO4} - k_{APO4} \cdot A}{k_{PO4}^T}$$

8. Dissolved Oxygen (O_2)

$$O2_t = O2SAT_t^T - D_t$$

$$L_t^{NH3} = 3.43 \cdot NH3_t$$

$$L_t^{NO2} = 1.14 \cdot NO2_t$$

$$D_t = (D_0 - \overline{\underline{K}}_1^D - \overline{\underline{K}}_2^D - \overline{\underline{K}}_3^D - \overline{\underline{K}}_4^D - \overline{\underline{K}}_5^D)\ \exp(-k_R^T t)$$

$$+\overline{\underline{K}}_1^D \exp(-(K_L^T + k_{LS}^T)t) + \overline{\underline{K}}_2^D \exp(-k_{NH3}^T t)$$

$$+\overline{\underline{K}}_3^D \exp(-k_{NO2}^T\ t) + \overline{\underline{K}}_4^D \exp(-k_{SS}^T t)$$

$$+\overline{\underline{K}}_5^D$$

where $\overline{\underline{K}}_1^D = \dfrac{k_L^T (L_0 - \overline{\underline{K}}_1^L)}{k_R^T - (k_L^T + k_{LS}^T)}$

$$\overline{\underline{K}}_2^D = \frac{3.43\ k_{NH3}^T\ (NH3_0 - \overline{\underline{K}}_1^n - \overline{\underline{K}}_2^n) + 1.14\ k_{NO2}^T\ \overline{\underline{N}}_1}{k_R^T - k_{NH3}^T}$$

$$K_3^D + \frac{1.14\ k_{NO2}^T\ (NO2_0 - \overline{\underline{N}}_1 - \overline{\underline{N}}_2 - \overline{\underline{N}}_3)}{k_R^T - k_{NO2}^T}$$

$$K_4^D = \frac{3.43\ k_{NH3}^T\ \overline{\underline{K}}_1^n + 1.14\ k_{NO2}^T\ \overline{\underline{N}}_2}{k_R^T - k_{SS}^T}$$

Table 4 (Cont'd)

$$\underline{K}_5^D = (k_L^T \underline{K}_1^L + 3.43\ k_{NH3}^T \underline{K}_2^n + 1.14\ k_{NO2}^T \underline{N}_3 - S_{O2}^T + S_{SOD}^T)/k_R^T$$

9. Conservative Attributes

$$CONSi_t = CONSi_o$$

10. Nonconservative Attributes

$$NCONi_t = (NCONi_o - \frac{S_{NCONi}}{k_{NCONi}^T})\ \exp(-k_{NCONi}^T t) + \frac{S_{NCONi}}{k_{NCONi}^T}$$

11. Temperature

$$T_t = (T_o - \underline{\bar{K}}^T)\ \exp(-k_T t) + \underline{\bar{K}}^T$$

where

$$k_T = 1.17 \times 10^{-3} + \rho L(a + bV)(\beta_j + 6.1 \times 10^{-4}\ P)$$

$$K^T = (q_{SN} + q_{at} - 7.36 \times 10^{-2} - \rho L(a + bV)(\alpha_j - e_a - 6.1 \times 10^{-4}\ p \cdot AT)/k_T$$

4 RATIONAL THRESHOLD VALUE TEST MODELS

An analytical approach such as that provided by RIAS requires measurable indicators of impact significance. To determine such significance, threshold values must be established. Therefore, it is necessary to develop concepts for using RTVs to measure the significance of impacts within the aquatic environment. The RTVTEST models used to develop RIAS are a subset of available models.[1] Impacts can be analyzed at three levels of effect by applying one or more of the following tests:

1. WQRTV -- Assessment of the extent of predicted violation of existing ambient water quality standards.

2. SIRTV -- Assessment of the effect of organic pollution on the microbial community.

3. TURTV -- Assessment of the expected concentrations of toxic compounds on overall environmental toxicity of receiving system (species-specific).

The flexibility of RIAS allows these RTVTESTs to be used singly or in conjunction with each other.

Water Quality Standard Assessments (WQRTV)

This RTVTEST quantifies the magnitude of water quality violations which will be caused by the impacts of the project being evaluated. This test is relatively straightforward, comparing existing stream standards to the output of pertinent SIMWQ attributes. Impact is quantified in terms of the degree of violation (mg/ℓ) at specific points in the WQ (i,j,k) profile, the spatial extent of violations (mg/ℓ/miles), and the temporal extent of violations. The RTV level in this case is the existing water quality standard.

Saprobic Indices (SIRTV)

This system[2] was developed as an empirical relationship between aquatic organisms and organic water pollution. This relationship has been termed the Saprobian system and uses the concept of an indicator species. The application of the empirical relationships of the Saprobian system in a quantitative index was introduced by Pantle and Buck[3] and expanded by Sladecek.[4] They

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1 E. E. Herricks and M. J. Sale, Development of Rational Threshold Values for Aquatic Ecosystems (University of Illinois, 1978).

2 R. Kolwitz and M. Marsson, "Okologie der Pflanzlichen Saprobien," Ber. Dt. Bot. Ges., Vol 26A (1908), pp 505-519.

3 R. Pantle and H. Buck, "Die Biologische Uberwachung der Gewasser und die Darstellung der Ergebnisse," Gas. Wass. Fach., Vol 96, No. 604 (1955).

4 V. Sladecek, "The Measures of Saprobity," Verh. Int. Ver. Limnol., Vol 17 (1969), pp 546-559; and V. Sladecek,"System of Water Quality from the Biological Point of View," Erg. Limnol., Vol 7 (1973), pp 1-218.

describe the Saprobic index S as ranging between 1 and 4 and 1 and 8, respectively. Other literature has shown the relationship between the Saprobic index and BOD_5 in the stream.[5] Table 5 gives the relative values of S and BOD_5.[6] Saprobic indices have generally been used as a classification scheme in Europe, but have not been widely used in the United States.

The Saprobic index can easily be calculated[7] using BOD_5 concentrations provided by SIMWQ:

$$SI(i,k) = \frac{1.075(L(i,k)) - 0.473}{0.218(L(i,k)) + 0.904} \qquad \text{[Eq 3]}$$

$$\text{if} \quad 0 \leq L(i,k) \leq 50 \text{ mg}/\ell$$

$$= \frac{0.0189(L(i,k)) - 7.938}{0.0021(L(i,k)) - 1.882}$$

$$\text{if} \quad L(i,k) > 50 \text{ mg}/\ell$$

where SI(i,k) is the Saprobic index in i^{th} point in space and k^{th} point in time.

The values of SI(i,k) can then be used to interpret the impact of organic effluents on the community structure of the receiving stream. For example, RTV levels can be set at $SI(i,k) < 2.0$ for no significant impact and at $2 < SI(i,k) \leq 3$ for minimal impact; then the output from the SIRTV routine can be used to quantify the extent of temporal and spatial impacts within the aquatic environment.

Environmental Toxicity (TURTV)

The toxicity unit concept[8] has proven to be a useful tool for integrating biological response to both primary toxicants and modifying factors (e.g., dissolved oxygen [DO], temperature, pH, etc.). This index has been used successfully[9] to assess the biological significance of water pollution impacts. A toxic unit of a specific pollutant is simply a concentration equal to the

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5 J. Rothschein, "Saprobity as a Criterion of Oxygen Regime" (in Slovakian with English summary), Pr. Stud. VUVH Bratislave, Vol 63 (1972), pp 1-134; and V. Sladecek and F. Tucek, "Relation of the Saprobic Index to BOD_5," Water Res., Vol 9 (1975), pp 791-794.

6 V. Sladecek, "The Measures of Saprobity"; and "System of Water Quality from the Biological Point of View."

7 V. Sladecek and F. Tucek, "Relation of the Saprobic Index to BOD_5."

8 K. S. Lubinski, R. E. Sparks, and L. A. Jahn, Development of Toxicity Indices for Assessing the Quality of the Illinois River, Research Report No. 96, UILU-WRC-74-0096 (University of Illinois, 1974).

9 W. V. Brigham, D. A. McCormick, and M. J. Wetzel, The Watersheds of Northeastern Illinois: Quality of Aquatic Environment Based Upon Water Quality and Fishery Data, Staff Paper No. 31, NIPC (Illinois Natural History Survey, 1978).

96-hour LC_{50} for a target organism.* Toxic units are calculated as the ratio of simulated ambient concentrations of an attribute divided by its LC_{50}. This ratio is also analogous to a pollutant's application factor,[10] and a threshold level can be specified to ensure protection for target organisms (e.g., requiring a toxic unit $\leq$ 0.01 would be equivalent to an application factor of 100, which is used for many chlorinated hydrocarbons). Toxic units can also be accumulated (summed) for all potential toxicants to obtain an overall index of environmental toxicity. Experience has indicated acceptable levels of total toxicity units,[11] but one must remember that this index is just a first approximation of biological response.

The problems involved with measuring environmental toxicity include adjusting for the effects of environmental modifiers and predicting synergistic effects of various pollutant combinations. Information on the effects of combinations of toxicants is available for only a few species, but more data are being collected daily. However, despite these limitations, the toxic unit model is still the best general model now available for impact assessment. When toxicity data are available at multiple trophic levels, the toxic units can also be used at various levels to measure the sensitivity of aquatic communities.

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* LC_{50} is a measure of the concentration level of the toxic material that will kill 50 percent of the species being used in the test within a given time interval (e.g., 96 hours).

[10] Quality Criteria for Water (U.S. Environmental Protection Agency [USEPA], 1976).

[11] R. Lloyd and D. H. M. Jordan, "Predicted and Observed Toxicities of Several Sewage Effluents to Rainbow Trout," J. and Proc. Inst. Sew. Purif. (Brit.), Vol 2 (1963), pp 183-186.

Table 5

Values of S and BOD_5 (=L) for Upper Limits of Individual Saprobic Degrees*

Degree	S	L	Note
Katharobity	-0.5	0.0	Purest water
Zernosaprobity	0.5	1.0	Very clean
Oligosaprobity	1.5	2.5	Clean
Beta-mesosaprobity	2.5	5.0	Mild pollution
Alpha-mesosaprobity	3.5	10.0	Pollution
Polysaprobity	4.5	50.0	Heavy pollution
Isosaprobity	6.5	400.0	Sewage
Metasaprobity	6.5	700.0	Septic
Hypersaprobity	7.5	2,000.0	Putrefaction
Ultrasaprobity	8.5	120,000.0	Lifeless liquors

*From V. Sladecek, "The Measures of Saprobity," Verh. Int. Ver. Limnol., Vol 17 (1969), pp 546-559; and V. Sladecek "System of Water Quality from the Biological Point of View," Erg. Limnol., Vol 7 (1973), pp 1-218.

5 APPLICATIONS

This chapter provides a series of application scenarios which demonstrate the utility of RIAS. Appendices A and B provide sample output of the RIAS system application. These examples concentrate on problems pertinent to current Army activities, but are not meant to be exhaustive. The role of RIAS or a similarly designed methodology in improving impact planning will become apparent in this discussion.

The general framework for decision-making using RIAS should be envisioned as an iterative process using the three computerized procedures -- FQUES, SIMWQ, and RTVTEST -- as the central tools. Adequate methods for impact scoping presently exist in the form of matrix methodology such as the Environmental Impact Computer System (EICS),[12] a computerized system to help environmental planners identify and mitigate impacts of proposed Army projects or activities. However, a shortcoming of matrix methodology is that it is not a data-handling tool and provides little, if any, quantification potential. This is the purpose of developing secondary algorithms like RIAS for impact assessment. While computer-based matrix methodologies work well for specifying a project's potential impacts, they cannot detect small changes in project specifications which may mean the difference between significant or nonsignificant impacts. RIAS, which has this capability, uses quantitative procedures to integrate impacts according to changes in project specifications. Environmental setting data are used to predict impact magnitudes. Subsequent to initial use of these procedures, project specifications can be changed, allowing impact assessment of various alternatives to be done easily and inexpensively. In this way, the RIAS methodology provides a truly quantitative tool for impact management.

Besides quantification, another major advantage of RIAS is standardization. The computer-based algorithms define the organization of environmental information and specify its use in a consistent, repeatable protocol. At this time, the links between primary-level impact assessment (i.e., scoping activities like EICS) and secondary procedures such as RIAS should be via paper ties only. This could be in the form of RAMIT (ramification/mitigation) statements output from EICS, descriptor package writeups, and user manuals such as the appendices to this report. Ultimately, if a system such as RIAS received broad-based support, data sets specifying environmental setting could be assembled for all Army bases, providing "off the shelf" assessment capability whenever new missions altered base operations. Since the goals of impact modeling should be flexibility and easily usable prediction tools coupled to readily available data sets, RIAS can be seen as a design prototype for this type of methodology.

The following sections provide examples of how RIAS can be applied to assessing environmental impacts resulting from Army projects.

[12] R. Baran and R. D. Webster, Interactive Environmental Impact Computer System (EICS) User Manual, Technical Report N-80/ADA074890 (U.S. Army Construction Engineering Research Laboratory [CERL], September 1979).

Example 1

The impacts occurring in aquatic receiving systems which are the most frequently studied originate from point source discharges of domestic sewage effluents. This type of effect must be considered in environmental impact statements and/or assessments of Army activities. Receiving stream impacts caused by organic pollution occur when mission changes alter sewage treatment plant loadings or treatment efficiencies or when old sewage treatment plants are upgraded. RIAS provides an assessment tool for analyzing these situations. The BOD/DO models within RIAS are only a subset of a more general model. The outputs from both WQRTV and SIRTV quantify these types of impacts and place impact predictions in easily understandable terms. (See Appendix B, Part 3.)

Example 2

Waste discharges from many Army industrial or laboratory activities contain toxic components which can adversely affect aquatic biota. The magnitude and spatial extent of these impacts are largely a function of environmental setting, such as watershed dilution capacity, ambient water quality, and local target species. The TURTV routine in RIAS provides a consistent method of considering such information and quantifying impact magnitude using the toxic unit concept. (See Appendix A, Part 3, Section C.)

Example 3

Vehicle maintenance activities account for point source discharges of many potentially harmful water quality attributes, including suspended solids, detergents, oils and greases, and general BOD. While washrack facilities are being redesigned and relocated, the impacts of these facilities within a watershed context could be evaluated using the RTVTESTs in RIAS. Thus, site-specific design activities could be made more efficient by considering the watershed assimilation capacity of sensitivity (Appendix B, Part 3) as shown by RIAS.

Example 4

Impacts from landfill leachate are increasingly affecting the aquatic environment. The significance of these impacts depends on many factors, including the water body's assimilative capacity and the sensitivity of biota in the receiving watershed. RIAS is an excellent tool for evaluating the severity of these impacts. If leachate rates and initial concentrations can be estimated and isolated in a watershed, a simulated point source discharge can be created to represent leachate inputs. (See Appendix B, Part 3.)

Organization of Information Inputs

The first step in using the RIAS computer routines for an impact assessment is organizing the data sources and describing the problem. This requires several stages of data collection and organization, including: (1) identification of the control parameters for simulation and assessments, (2) collection of data on boundary conditions for the analysis, and (3) estimation of kinetic rate coefficients and source/sink terms for the water quality simulations.

The first step is determining the impact types to be considered and the geometric description of the watershed to be analyzed. Potential impacts must have already been identified by some type of scoping procedure (e.g., EICS). Physical and chemical water quality attributes are required at this point, as well as environmental modifiers which might be important in weighing impact significance. This information is used to specify the attributes to be modeled in SIMWQ. The watershed description consists of identifying reach lengths, drainage areas upstream from the top of each stream reach, tributary and effluent locations, and bifurcation structure. (Chapter 2 provides criteria for specifying reaches.) Drainage areas are calculated using standard U.S. Geological Survey maps.

The technique to be used for numbering reaches, bifurcations, tributaries, and effluents is:

1. Numbering reaches: Number reaches beginning at the top of the most upstream minor branch of the stream to be modeled. Proceed downstream until a confluence is encountered. Skip to the top of the next most upstream minor branch and continue downstream to the next confluence. When no more minor branches remain, proceed down the main branch from upstream to downstream.

2. Numbering bifurcations: Each channel bifurcation (confluence location) is designated by a real number consisting of digits in the tens, ones, tenths, and hundredths places. For example, for "10.05," the whole number part of the indicator ("10" in this example) represents the receiving reach downstream of the confluence. The fractional part of the indicator ("5" in this example) represents the last reach of the minor branch which is entering a higher-order stream.

3. Numbering tributary inputs: Using the numbering system described above, number upstream tributaries first, doing the more minor branches first. This convention is not critical, but will provide more consistency. Remember that the inputs at the top reach of each branch must be designated as a tributary in order to set boundary conditions for the simulation model. The index of each tributary designates the stream reach into which it empties, not simply its number.

4. Numbering effluent inputs: Using the numbering system described above, number effluents in an upstream to downstream manner. As with tributaries, the index number of an effluent represents the number of the reach into which it empties, not the number of the effluent.

The second stage of data organization is specifying boundary conditions of water quality attributes at tributaries and effluents within the watershed. Techniques for doing mass balances on Army installations are available which are adequate for describing effluents.[13] Another source of effluent information is the National Pollutant Discharge Elimination System (NPDES) permits for point source discharges. Many sources are available that describe information on tributary inputs.[14] However, when no information on boundary conditions is available, field data must be collected.

The last stage of data organization is specifying the kinetic terms in SIMWQ equations. This is the most important requirement for ensuring accurate impact assessment. The structure used in SIMWQ takes advantage of a class of widely used simulation models (steady-state, plug flow) whose parameters are well understood. The review of Zison, et al., is a good primary source of information on the state of the art of estimating these model parameters.[15] Table 2 provides a range of values experienced for all model terms and references to previous modeling work in which they were used.

Example Problem

To illustrate the use of all the RIAS routines, Appendix B provides an example impact assessment. Figure 3 shows the layout of a hypothetical Army post where the potential impacts from four point sources of pollutants on aquatic receiving systems will be analyzed. Pre-analysis information has already been organized, and the example begins as FQUES is executed to build up the project specification/environmental setting data base. All user responses in the computer output have been underlined.

[13] G. W. Schanche, et al., Water/Wastewater Survey Guidelines, Technical Report N-11/ADA033223 (CERL, 1976).

[14] E. E. Herricks and M. J. Sale, Development of Rational Threshold Values for Aquatic Ecosystems (University of Illinois, 1978).

[15] S. W. Zison, et al., Rates, Constants and Kinetic Formulations in Surface Water Quality Modeling, EPA-600/3-78-105 (USEPA, 1978).

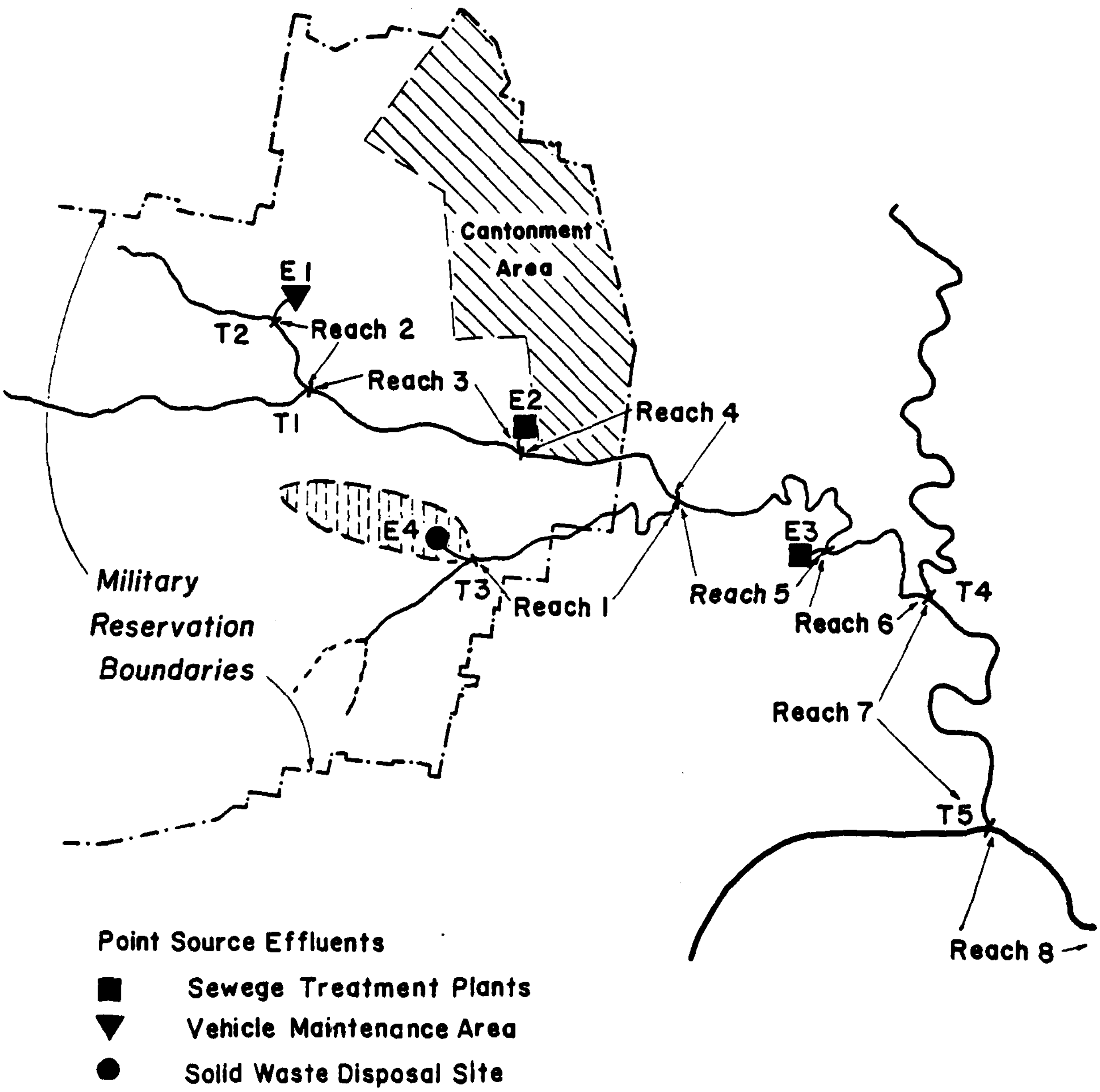

Figure 3. Physical layout for example problem.

7 CONCLUSION

This report has described the framework and demonstrated the utility of RIAS, a computerized technique which uses the concept of rational threshold values to determine impact significance. This system uses a rigorous set of analysis procedures to identify significant effects resulting from Army activities on aquatic ecosystems.

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APPENDIX A:

ANALYTICAL SOLUTIONS USED IN SIMWQ

The general solution used in the SIMWQ equations is demonstrated here for a simple steady-state situation of coupled water quality attributes.* The equations developed here are used only within a stream reach in which all model parameters are constant. Implicit assumptions are:

1. Nondispersive, plug flow
2. Temporal steady-state conditions at all upstream loading points, source/sink terms, and stream discharge
3. First-order reaction kinetics.

The initial system of coupled reaction is given by:

$$\frac{dA_t}{dt} = -k_1A_t + S_A \qquad \text{[Eq A1]}$$

$$\frac{dB_t}{dt} = -k_2B_t + k_3A_t + S_B$$

where:

A_t = concentration of attribute A at time t

B_t = concentration of attribute B at time t

The general solution is:

$$A_t - S_{Ak_1} + (A_o - \frac{S_A}{k_1)} \exp(-k_1t) \qquad \text{[Eq A2]}$$

$$B_t = [\frac{k_3S_A}{k_1k_2} + \frac{S_B}{k_2}] +$$

$$[B_o + \frac{k_3S_A}{k_1(k_2 - k_1) - \frac{k_3A_o}{k_2 - 1} - \frac{k_3S_A}{k_1k_2} - \frac{S_B}{k_2}}] \exp(-k_2t)$$

$$+ [\frac{k_3A_o}{(k_2 - k_1) - \frac{k_3S_A}{k_1(k_2 - k_1)}}] \exp(-k_1t)$$

---

* A more detailed discussion of this type of equation development can be found in Chapters 4 and 5 of R. V. Thomann, Systems Analysis and Water Quality Management (McGraw-Hill, 1972).

Generally, this type of solution takes on the form:

$$C_t = \alpha + \sum_{i=1}^{n} \beta_i \exp(-\gamma_i t) \qquad \text{[Eq A3]}$$

where α, β_i, and λ_i are constants within a reach which can be calculated from data inputs, and C_t is the concentration of any attribute at time t.

In some cases, this analytical solution degenerates; i.e., if k_2 is input as zero or if $k_2 = k_1$, the result will be an illegal arithmetic operation. Therefore, contingencies have been made in the FORTRAN code to avoid this type of solution breakdown. Using the coupled system defined initially, four conditions can be identified which cause a breakdown:

1. $k_1 = 0$, k_2 nonzero
2. $k_2 = 0$, k_1 nonzero
3. $k_1 = k_2 = 0$
4. $k_2 = k_1 \neq 0$.

The solutions used to avoid blowup in SIMWQ can be derived as follows:

<u>Condition 1</u> ($k_1 = 0$, $k_2 \neq 0$):

$$A_t = a_0 + S_A t \qquad \text{[Eq A4]}$$

$$B_t = [\frac{k_3 A_o}{k_2} + \frac{S_B}{k_2}] + (B_o - \frac{k_3 A_o + S_b}{k_2} \exp(-k_2 t) + \frac{1}{2} k_3 S_A t^2$$

<u>Condition 2</u> ($k_2 = 0$, $k_1 \neq 0$):

$$A_t = \frac{S_A}{k_1} + (A_D - \frac{S_A}{k_1}) \exp(-k_1 t) \qquad \text{[Eq A5]}$$

$$B_t = [\frac{S_A}{k_1} - \frac{k_3 A_o}{k_1}] \exp(-k_1 t) + [S_B + \frac{k_3 S_A}{k_1}] t$$

<u>Condition 3</u> ($k_1 = k_2 = D$):

$$A_t = A_o + S_A t \qquad \text{[Eq A6]}$$

$$B_t = B_o + S_B t$$

<u>Condition 4</u> ($k_1 = k_2 \neq 0$):

$$A_t = \frac{S_A}{k_1} + (A_0 - \frac{S_A}{k_1)} \exp(-k_1 t) \qquad \text{[Eq A7]}$$

$$B_t = (\frac{k_3 S_A}{k_1 k_2} + \frac{S_B}{K_2}) + (B_0 - \frac{k_3 S_A}{k_2 k_1} - \frac{S_B}{k_2} \exp(-k_2 t)$$

$$+ k_3 (A_0 - \frac{S_A}{k_1})t \exp(-k_1 t)$$

This same type of logic and equation formulation is applied to all sets of coupled equations in SIMWQ. Because of the additional terms compounded in t, the form of the general solution is expanded to

$$C = \alpha + \sum_{i=1}^{n} \beta_i \exp(-\gamma_i t) + \delta t + \varepsilon t \exp(\rho t) \qquad \text{[Eq A8]}$$

As before, all the constant terms, $\alpha, \beta, \gamma, \delta, \varepsilon, \rho$, can be calculated based on input for each reach and C could be the concentration of any attribute. These terms are all calculated in the subprogram APARAM, which also includes the logic to avoid unnecessary breakdowns in the computer software codes. This logic increases the usability of the final product and requires a minimum of user expertise.

APPENDIX B:

RIAS USE EXAMPLE

Part 1: New Data File Creation

```
 TERMINAL:    257
 79/12/18. 10.32.43.
 UNIVERSITY OF ILLINOIS CYBER 175.      NOS 1.3 - 485/485.

SIGNON: 341447562
PASSWORD
[redacted]
TERMINAL:     257, TTY
RECOVER/ CHARGE: bill,ceusa,ps7770
 LAST RECORDED SIGNON AT 10:23 12/18/79
/-fques


          ##########################################
          #                                        #
          #          THIS PROGRAM ALLOWS           #
          #       THE USER TO BUILD UP A NEW       #
          #   DATA FILE OR TO REVISE AN OLD DATA   #
          #    FILE FOR SUBSEQUENT CONTROL AND     #
          #      INPUT FOR WATER QUALITY SIM-      #
          #          ULATONS UNDER 'RIAS'          #
          #                                        #
          ##########################################


      DO YOU WISH TO BEGIN CREATING A NEW DATA FILE
           (ANS: YES OR NO) ? y

             ==================================
                  TIME INVARIANT PARAMETERS
             ==================================

      I)  TYPE IN THE NAME OF THE DATA SET
? example no. 1
```

```
II)  ANSWER THE FOLLOWING QUESTIONS ABOUT SIMULATION
          CONTROL PARAMETERS.

     HOW MANY REACHES (ANS:1-20)  ? 8
     HOW MANY TIME PERIODS (ANS:1-12) ? 2
     HOW MANY ADDITIONAL CONSERVATIVE WATER QUALITY
          ATTRIBUTES BEYOND THE CORE ATTRIBUTES
          (ANS: 0-12) ? 3
     HOW MANY ADDITIONAL NONCONSERVATIVE ATTRIBUTES
          (ANS: 0-4)  ? 2
     INPUT THE NAMES OF THESE ADDITIONAL PARAMETERS.
          CONSERVATIVE ATTRIBUTES:
               ATT. NO. 9)? hard.
               ATT. NO. 10) ? ph
               ATT. NO. 11) ? zn
          NONCONSERVATIVE ATTRIBUTES:
               ATT. NO. 12) ? cl2
               ATT. NO. 13) ? coli.
     INPUT THE MODELING CODES FOR THE EIGHT CORE
          ATTRIBUTES (ANS: 0 OR 1)
          ? 0,1,1,1,1,1,1,1

III)  INPUT THE PARAMETERS DESCRIBING THE WATERSHED
          STRUCTURE FOR THIS SIMULATION.

          HOW MANY TRIBUTARY INPUTS ? 5
               INPUT CODES:
                1)? 3
                2)? 2
                3)? 1
                4)? 7
                5)? 8
          HOW MANY POINT SOURCE DISCHARGES  ? 4
               INPUT CODES:
                1)? 2
                2)? 4
                3)? 6
                4)? 1
          HOW MANY MAIN BRANCH BIFURCATIONS ? 1
               BIFURCATION CODES:
                 1) ? 5.01

          INPUT THE LENGTH OF EACH REACH AND THE
               DRAINAGE AREA UPSTREAM FROM THE
               TOP OF EACH REACH (ANS: MILES AND
               SQUARE MILES).
                1)? 3.2,1.8
                2)? .8,1.3
                3)? 2.5,4.9
                4)? 2.2,6.3
                5)? 3.5,11.1
                6)? 2.1,13.0
                7)? 5.7,32.
                8)? 20.,990.

IV)  INDICATE HOW YOU WISH TO MODEL STREAM
     HYDRAULICS.
          0)  MEAN DEPTH AND VELOCITY SPECIFIED
              FOR EACH REACH AND TIME PERIOD.
          1)  HYDRAULIC RATING PARAMETERS USED FOR
              EACH REACH.
          (ANS: USE EITHER 0 OR 1)? 0
```

```
    ZERO TIME VARIANT PARAMETERS FIRST (Y OR N) ? n

 ==================================================
   TIME VARIANT PARAMETERS FOR TIME PERIOD NO. 1
 ==================================================


    I)  HYDRAULIC PARAMTERS.

         INPUT MEAN VELOCITIES FOR EACH REACH.
        ? .28,.17,.23,.25,.29,.3,.38,.93 .

         INPUT MEAN DEPTHS FOR EACH REACH.
        ? .16,.14,.2,.22,.25,........
 22,.25,.. < ERROR, RETYPE RECORD AT THIS FIELD
? .25,.33,.8

    II)  BOUNDARY CONDITIONS AT TRIBUTARIES.

         INPUT AMBIENT WATER QUALITY CONDITIONS FOR
         TRIBUTARIES 1 THROUGH 5
         TEMP.      ? 20.1,20.1,20.1,25.2,25.2, *DEL*
20.1,20.1,20.,25.2,27
         BOD5       ? .5,.5,.5,1.0,1.2
         TSS        ? 10.,10.,11.6,21.,25.
         NH3        ? 0,0,0,0,0
         NO2        ? 0,0,0,0,0
         NO3        ? 1.3,1.3,.5,2.6,2.8
         PO4        ? .05,.05,.05,.5,.5
        _D.O.       ? 8.25,8.25,8.25,7.6,7.9
         HARD.      ? 220,220,220,295,295
         PH         ? 7.9,7.9,7.75,7.9,7.9
         ZN         ? 0.,0.,0,0,0
         CL2        ? 0,0,0,0,0
         COLI.      ? 0,0,0,0,0

         MEAN DISCHARGE? .03,.09,.05,.5,28

    III)  BOUNDARY CONDITIONS AT EFFLUENT DISCHARGES.

         INPUT AMBIENT WATER QUALITY CONDITIONS FOR
         EFFLUENTS 1 THROUGH 4
         TEMP.      ? 27.,25.4,22.,25
         BOD5       ? 5.9,186,200,.5
         TSS        ? 8,124,250,12
         NH3        ? .5,22.6,1.5,10.
         NO2        ? 0,0,0,0.
         NO3        ? 9.8,0.2,0.,0.
         PO4        ? 6.1,10.1,12.,0.
         D.O.       ? 7.8,6.1,3.2,0.2
         HARD.      ? 150,150,450,300
         PH         ? 7.6,7.6,6.6,6.0
         ZN         ? 0.5,0.2,1.4,2.5
         CL2        ? 1.5,1.0,0.,0.
         COLI.      ? 100.,100.,0.0.
```

```
        MEAN DISCHARGE? 2..3..1...2

    IV)  REACTION RATE COEFFICIENTS.

         INPUT THE INDICATED RATE COEFFICIENT FOR
         REACHES 1 THROUGH 8

         KANH3        ? .05,.05..05,.05.,.05,.05,.05,.05
 ,.05,.05.  < ERROR, RETYPE RECORD AT THIS FIELD
? .05
? .05
? .05
? .05
? .05
         KANO3        ? .05,.05,,05,.05,.05,.05,.05,.05
         KAPO4        ? .01,.01,.01,.01,.01,.01,.01,.01
         KL           ? .16,.16,.16,.16,.16,.16,.16,.16
         KLS          ? .01,.01,.01,.012.01,.01,.01,.01
         KNDET        ? .02,.02,.02,.02,.02,.02,.02,.02
         KNH3         ? .65,.65,.65,.65,.65,.65,.65,.65
         KNO2         ? 2.5,2.5,2.5,2.5,2.5,2.5,2.5,2.5
         KNO3         ? .001,.001,.011,.001,.001,.011,.001,.001
         KPDET        ? .02,.02,.02,.02,,02,.02,.02,.02
         KPO4         ? .2,.2,.2,.2,.2,.2,.2,.2
         KR           ? 0,0,0,0,0,0,0,0,0
         KSS          ? .01,.01,.01,.01,.01,.01,.01,.01
         KSSS         ? 0,0,0,0,0,0,0,0
         KT           ? 0,0,0,0,0,0,0,0
         KTSS         ? .02,.02,.02,.02,.02,,02,.02,.02
         KNCA1        ? 0,0,0,0,0,0,0,0
         KNCA2        ? 0,0,0,0,0,0,0,0

    V)  DISTRIBUTED SOURCE/SINK PARAMETERS.

         INPUT THE INDICATED SOURCE/SINK TERM FOR
         REACHES 1 THROUGH 8
```

Part 2: Data File Revision

```
TERMINAL:     46
79/12/18. 13.42.04.
UNIVERSITY OF ILLINOIS CYBER 175.      NOS 1.3 - 485/485.

SIGNON: 341447562,bang
TERMINAL:     46, TTY
RECOVER/ CHARGE: bill,ceusa,ps7770
 LAST RECORDED SIGNON AT 11:55 12/18/79
/get,tape9
/-fques

JOB ACTIVE.


          ########################################
          #                                      #
          #          THIS PROGRAM ALLOWS         #
          #       THE USER TO BUILD UP A NEW     #
          #    DATA FILE OR TO REVISE AN OLD DATA #
          #     FILE FOR SUBSEQUENT CONTROL AND  #
          #       INPUT FOR WATER QUALITY SIM-   #
          #           ULATONS UNDER 'RIAS'       #
          #                                      #
          ########################################


      DO YOU WISH TO BEGIN CREATING A NEW DATA FILE
           (ANS: YES OR NO) ? n


      DO YOU WISH TO REVIEW AND/OR REVISE THE EXISTING
           DATA FILE
           (ANS: YES OR NO) ? y


 ======================================================
      REVIEW OF CONTENTS OF CURRENT DATA FILE
 ======================================================

      THE CURRENT CONTENTS OF YOUR DATA FILE HAVE THE
           TITLE:

      EXAMPLE NO. 1


      THIS DATA SET SPECIFIES SIMULATION OF THE
           FOLLOWING WATER QUALITY ATTRIBUTES:
      TEMP.     BOD5      TSS       NH3       NO2
      NO3       PO4       D.O.      HARD.     PH
      ZN        CL2       COLI.

      SIMULATIONS WILL BE RUN FOR 2 TIME PERIODS
          FOR A TOTAL OF 8 STREAM REACHES.
?
```

```
THE SPECIFIED WATERSHED STRUCTURE IS AS FOLLOWS:

REACH      LENGTH      DRAINAGE          INPUTS
 NO.       (MI.)       (SQ.MI.)       EFF.    TRIB.

  1        3.200        1.800          4        3
  2         .800        1.300          1        2
  3        2.500        4.900          **       1
  4        2.200        6.300          2        **
  5        3.500       11.100          **       **
  6        2.100       13.000          3        **
  7        5.700       32.000          **       4
  8       20.000      990.000          **       5

THE NUMBER OF MAJOR BIFURCATIONS OF THE MAIN
     CHANNEL OF THIS RECIEVING STREAM IS 1

BRANCH NO. 1 INCLUDES REACHES 1 TO 1

THE MAIN CHANNEL INCLUDES REACHES 2 TO 8
```

?

```
HYDRAULIC MODELING WILL BE DONE USING MEAN
     VELOCITIES AND DEPTHS FOR EACH REACH AND TIME
     PERIOD.

NONE OF THE ABOVE PARAMTERS CAN BE ALTERED WITHOUT
     CREATING A TOTALLY NEW DATA SET (I.E., BY
     STARTING OVER WITH 'FQUES').

DO YOU WANT TO CONTINUE (ANS: YES OR NO)? y

WHICH TIME PERIOD DO YOU WANT TO REVIEW ? 2

INDICATE WHICH OF THE FOLLOWING PARAMETERS YOU
     WANT TO REVIEW (RESPOND WITH THE PROPER NUMBER)
          1)  HYDRAULIC PARAMETERS
          2)  INITIAL CONDITIONS IN TRIBUTARIES
          3)  INITIAL CONDITIONS IN EFFLUENTS
          4)  KINETIC PARAMETERS
          5)  DISTRIBUTED SOURCE/SINK PARAMETERS
          6)  BIOLOGICAL PARAMETERS
      ? 4

INDICATE THE INDEX NUMBER OF THE KINETIC PARAMETER
     YOU ARE INTERESTED IN REVIEWING
          1)  KANH3
          2)  KANO3
          3)  KAPO4
          4)  KL
          5)  KLS
          6)  KNDET
          7)  KNH3
          8)  KNO2
          9)  KNO3
          10)  KPDET
          11)  KPO4
          12)  KR
          13)  KSS
          14)  KSSS
          15)  KT
          16)  KTSS
          17)  KNCA1
          18)  KNCA2
WHICH ONE ? 18
```

```
THE VALUES CURRENTLY SPECIFIED FOR KNCA2      WILL
     BE LISTED BELOW BY REACH.  TO CHANGE A VALUE
     RESPOND TO THE TRAILING '?' WITH THE NEW
     VALUE.
          1)  0.? .002
          2)  0.? .002
          3)  0.? .002
          4)  0.? .002
          5)  0.? .002
          6)  0.? .002
          7)  0.? .002
          8)  0.? .002
REVIEW ANOTHER RATE COEFFICIENT (ANS: YES OR NO)? n

CONTINUE FOR THIS TIME PERIOD (ANS: YES OR NO)? n

REVIEW ANOTHER TIME PERIOD (ANS: YES OR NO) ? y

WHICH TIME PERIOD DO YOU WANT TO REVIEW ? 1

INDICATE WHICH OF THE FOLLOWING PARAMETERS YOU
     WANT TO REVIEW (RESPOND WITH THE PROPER NUMBER)
          1)  HYDRAULIC PARAMETERS
          2)  INITIAL CONDITIONS IN TRIBUTARIES
          3)  INITIAL CONDITIONS IN EFFLUENTS
          4)  KINETIC PARAMETERS
          5)  DISTRIBUTED SOURCE/SINK PARAMETERS
          6)  BIOLOGICAL PARAMETERS
      ? 5

INDICATE THE INDEX NUMBER OF THE DISTRIBUTED
     SOURCE/SINK TERM YOU WISH TO REVIEW
          1)  SL
          2)  SNH3
          3)  SNO3
          4)  SO2
          5)  SPO4
          6)  SSOD
          7)  SSS
          8)  ST
          9)  SAT1
          10)  SAT2
          11)  SAT3
          12)  SAT4
          13)  SAT5
      ? 6

THE VALUES CURRENTLY SPECIFIED FOR SSOD       WILL
     BE LISTED BELOW BY REACH.  TO CHANGE A VALUE
     RESPOND TO THE TRAILING '?' WITH THE NEW
     VALUE.
          1)  0.? .6
          2)  0.?
          3)  0.?
          4)  0.? .6
          5)  0.? .6
          6)  0.? .6
          7)  0.? .9
          8)  0.? 1.2
REVIEW ANOTHER SOURCE/SINK TERM (ANS: YES OR NO)? n

CONTINUE FOR THIS TIME PERIOD (ANS: YES OR NO)? n

REVIEW ANOTHER TIME PERIOD (ANS: YES OR NO) ? y

WHICH TIME PERIOD DO YOU WANT TO REVIEW ? 2
```

```
INDICATE WHICH OF THE FOLLOWING PARAMETERS YOU
     WANT TO REVIEW (RESPOND WITH THE PROPER NUMBER)
          1)  HYDRAULIC PARAMETERS
          2)  INITIAL CONDITIONS IN TRIBUTARIES
          3)  INITIAL CONDITIONS IN EFFLUENTS
          4)  KINETIC PARAMETERS
          5)  DISTRIBUTED SOURCE/SINK PARAMETERS
          6)  BIOLOGICAL PARAMETERS
     ? 5

INDICATE THE INDEX NUMBER OF THE DISTRIBUTED
     SOURCE/SINK TERM YOU WISH TO REVIEW
          1)  SL
          2)  SNH3
          3)  SNO3
          4)  SO2
          5)  SPO4
          6)  SSOD
          7)  SSS
          8)  ST
          9)  SAT1
          10)  SAT2
          11)  SAT3
          12)  SAT4
          13)  SAT5
     ? 6

THE VALUES CURRENTLY SPECIFIED FOR SSOD      WILL
     BE LISTED BELOW BY REACH.  TO CHANGE A VALUE
     RESPOND TO THE TRAILING '?' WITH THE NEW
     VALUE.
          1)  0.?
          2)  0.?
          3)  0.?
          4)  0.? .6
          5)  0.? .6
          6)  0.? .6
          7)  0.? .8
          8)  0.? 1.2
REVIEW ANOTHER SOURCE/SINK TERM (ANS: YES OR NO)? n

CONTINUE FOR THIS TIME PERIOD (ANS: YES OR NO)? n

REVIEW ANOTHER TIME PERIOD (ANS: YES OR NO) ? n


   YOUR DATA SET IS STORED IN THE FILE 'TAPE9'.
   REMEMBER TO SAVE OR REPLACE IT IF YOU WANT TO
   USE IT IN A LATER SESSION.

NOTE.!!
/replace,tape9
```

Part 3: RTV Test Using Data File Created and Revised

```
              SIMULATIONS HAVE BEEN STARTED
                USING THE FILE 'TAPE9' AS
                     CONTROL INPUT.
=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+

     SIMULATED WATER QUALITY PROFILES HAVE BEEN
          OUTPUT TO 'TAPE33' FOR 2 TIME
          PERIOD(S) FOR THE FOLLOWING WATER
          QUALITY ATTRIBUTES:

     1)  TEMP.
     2)  BOD5
     3)  TSS
     4)  NH3
     5)  NO2
     6)  NO3
     7)  PO4
     8)  D.O.
     9)  HARD.
     10)  PH
     11)  ZN
     12)  CL2
     13)  COLI.

=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+



     WATER QUALITY SIMULATIONS COMPLETE.
     YOU MAY NOW PROCEED TO RTV TESTING.
     REMEMBER TO SAVE OR REPLACE 'TAPE33' IF
     YOU PLAN TO USE IT IN LATER SESSONS.

NOTE.!!
/replace,tape33
/-wqrtv

 LOADER INFORMATION.
    MAP OPTIONS  =  OFF
    GLOBAL LIBRARY SET IS -
 GCSALPH



 +=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+
 +  THIS RTV ROUTINE TESTS FOR VIOLATIONS OF AMBIENT    +
 +      WATER QUALITY STANDARDS AND QUANTIFIES THE      +
 +          SPACIAL EXTENT OF THESE VIOLATIONS          +
 +=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+

 ---------------------------------------------------------
      EXAMPLE NO. 1

 ---------------------------------------------------------

       ..DICATE WHICH WATER QUALITY ATTRIBUTE(S) ARE
             TO BE ANALYZED.
           1)  TEMP.             5)  NO2
           2)  BOD5              6)  NO3
           3)  TSS               7)  PO4
           4)  NH3               8)  D.O.
                      9)  HARD.
                      10)  PH
                      11)  ZN
                      12)  CL2
                      13)  COLI.
      RESPOND WITH THE TOTAL NUMBER OF ATTRIBUTES
           FOLLOWED BY THE APPROPRIATE INDEX NUMBERS
      ? 5,2,3,4,8,11
```

```
-----------------------------------------------------------
  INPUT LOCAL AMBIENT WATER QUALITY STANDARDS
-----------------------------------------------------------


     .ME PERIOD NO. 1

    BOD5
    UPPER LEVEL STANDARD  ? 10
    LOWER LEVEL STANDARD  ?

    TSS
    UPPER LEVEL STANDARD  ? 12
    LOWER LEVEL STANDARD  ?

    NH3
    UPPER LEVEL STANDARD  ? 1.5
    LOWER LEVEL STANDARD  ?

    D.O.
    UPPER LEVEL STANDARD  ?
    LOWER LEVEL STANDARD  ? 6.

    ZN
    UPPER LEVEL STANDARD  ? 1.0
    LOWER LEVEL STANDARD  ?

    STANDARDS CONSTANT OVER TIME (Y OR N) ? y


=========================================================
   REPORT ON WATER QUALITY VIOLATIONS
=========================================================


    1)  TOTAL RIVER MILES IN VIOLATION OF STANDARDS.

                                     TIME PERIOD
  ATTRIBUTE          1      2      3      4      5      6
  ---------         ---    ---    ---    ---    ---    ---
   BOD5            33.5   13.5
   TSS             33.5   33.5
   NH3             16.7   10.3
   D.O.             0.0    0.0
   ZN               3.2    0.0


    DO YOU WANT A GRAPHICAL OUTPUT FOR ANY ATTRIBUTE
         PROFILES (ANS: YES OR NO)? y
```

```
     ATTRIBUTS NUMBER  ? 2

     TIME PERIOD ? 1
                        BOD5 :  TIME PERIOD NO.  1


 120 +
     +
C110 +         00
O100 +         0 00    00
N 90 +         0  000  0 00
C 80 +         0    0000  000
. 70 +         0             00000
     +         0                  00
( 60 +         0                   0
M 50 +         0                   0
G 40 +         0                   0
/ 30 +         0                   0
L 20 +         0                   0
)    +         0                   000000000000000
  10 .............................................................S
   0 000000++++++++++++++++++++++++++++++++++++++++++++++++++++++++
     0     4     8    12    16    20    24    28    32    36    40
        2     6     10    14    18    22    26    30    34    38
                      DISTANCE DOWNSTREAM (MILES)

     PLOT BOD5       FOR ANOTHER TIME PERIOD ? y

     TIME PERIOD ? 2
                        BOD5 :  TIME PERIOD NO.  2


 55 ++
    ++         0
C50 +          0000     000
O45 ++         0  0     0  0
N40 ++         0  0     0  0
C   ++         0   000000  0
.35 +          0           0
 30 ++         0           0
(25 ++         0           0
M   ++         0           0
G20 +          0           00000000
/15 ++         0                  00
L'0 ..............................................................S
)   ++         0                   0
  5 +    00    0                   0
  0 00000000000+++++++++++++++++++000000000000000000000000000000000
    0     4     8     12    16    20    24    28    32    36    40
       2     6      10    14    18    22    26    30    34    38
                     DISTANCE DOWNSTREAM (MILES)
```

```
PLOT BOD5        FOR ANOTHER TIME PERIOD ? n
PLOT ANOTHER WATER QUALITY ATTRIBUTE  ? y

ATTRIBUTE NUMBER  ? 3

TIME PERIOD ? 1
                   TSS  :  TIME PERIOD NO.  1


  100 +
   95 +                 0000
C  90 +                 0  0000000000
O  85 +                 0           0
N  75 +         0000    0           0
C  70 +         0  000000           0
.  65 +         0                   0
   55 +         0                   0
(  50 +         0                   0
M  40 +         0                   00000
G  35 +         0                        00000000000000000000000000
/  30 +         0
L  20 +         0
)  15 ............................................................S
    5 +    000000
    0 +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
        0     4     8    12    16    20    24    28    32    36    40
           2     6    10    14    18    22    26    30    34    38
                       DISTANCE DOWNSTREAM (MILES)

PLOT TSS         FOR ANOTHER TIME PERIOD ? y

TIME PERIOD ? 2
                   TSS  :  TIME PERIOD NO.  2


   50. +
  47.5 +                 0000
C  45. +                 0  0
042.5 +         0000    0  0
N37.5 +         0  0    0  0
C  35. +         0  000000  0
.32.5 +         0          0000000000
  27.5 +         0                   0
(225. +         0                   000000000000000000000000000000
M  20. +         0
G17.5 +         0
/115. +         0
L  10. ...........................................................S
)  7.5 +
   2.5 +
    0. ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
        0     4     8    12    16    20    24    28    32    36    40
           2     6    10    14    18    22    26    30    34    38
                       DISTANCE DOWNSTREAM (MILES
```

```
PLOT TSS          FOR ANOTHER TIME PERIOD ? n
PLOT ANOTHER WATER QUALITY ATTRIBUTE   ? y

ATTRIBUTE NUMBER   ? 4

TIME PERIOD ? 1
                    NH3  :  TIME PERIOD NO.  1


   14. +
       +         0
  C13. +         0
  O12. +         00
  N11. +         0 0
  C10. +         0  0
  . 9. +         0  0
    8. 0         0   00
  ( 7. +0        0    00
  M 6. +00       0      00
  G 5. +  00     0       0
  / 4. +   00    0        000
  L 3. +    0    0          00000
  ) 2. ............................................................S
    1. +    0    0                   0
    0. +++++000000+++++++++++++++++++0000000000000000000000000000000
       0     4     8     12    16    20    24    28    32    36   40
          2     6     10    14    18    22    26    30    34    38
                      DISTANCE DOWNSTREAM (MILES)

PLOT NH3          FOR ANOTHER TIME PERIOD ? y

TIME PERIOD ? 2
                    NH3  :  TIME PERIOD NO.  2


   6.5 +
       +         0
  C 6. +         00
  O5.5 +         0 00
  N 5. +         0  0
  C4.5 +         0  00
  . 4. +         0    000
   3.5 +         0       00
  ( 3. +         0         00
  M2.5 +         0          0
  G 2. +         0          0
  /    0000      0          0
  L1.5 ............................................................S
  ) 1. +    0    0           000000000
    .5 +    0    0                   0
    0. +++++000000+++++++++++++++++++0000000000000000000000000000000
       0     4     8     12    16    20    24    28    32    36   40
          2     6     10    14    18    22    26    30    34    38
                     . STANCE DOWNSTREAM (MILES)
```

```
PLOT NH3         FOR ANOTHER TIME PERIOD ? n
PLOT ANOTHER WATER QUALITY ATTRIBUTE   ? y

ATTRIBUTE NUMBER  ? 8

TIME PERIOD ? 1
                       D.O. :  TIME PERIOD NO.  1


 8.5 +
  8. +00000
C7.5 +0   00000000000000000000000000000000000000000000000000000000
O 7. +0        0       0
N6.5 +0
C 6. ............................................................S
.5.5 +0
 4.5 0
( 4. 0
M3.5 0
G 3. 0
/2.5 0
L1.5 0
) 1. +
  .5 +
  0. +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
     0     4     8    12    16    20    24    28    32    36    40
        2     6    10    14    18    22    26    30    34    38
                      DISTANCE DOWNSTREAM (MILES)

PLOT D.O.        FOR ANOTHER TIME PERIOD ? y

TIME PERIOD ? 2
                       D.O. :  TIME PERIOD NO.  2


 9.5 +
  9. +0000000000
C8.5 +0   00   0                                            000000
O 8. +0   0     00000000   0000000000000000000000000000000000
N7.5 0                 000
C6.5 0
. 6. ............................................................S
 5.5 +
(4.5 +
M 4. +
G3.5 +
/2.5 +
L 2. +
)1.5 +
  .5 +
  0. +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
     0     4     8    12    16    20    24    28    32    36    40
        2     6    10    14    18    22    26    30    34    38
                      DISTANCE DOWNSTREAM (MILES)
```

```
PLOT D.O.        FOR ANOTHER TIME PERIOD ? n
PLOT ANOTHER WATER QUALITY ATTRIBUTE  ? y

ATTRIBUTE NUMBER  ? 11

TIME PERIOD ? 1
                    ZN   :  TIME PERIOD NO.  1


  2. +
 1.9 000000
C1.8 +    0
01.7 +    0
N1.5 +    0
C1.4 +    0
.1.3 +    0
 1.1 +    0
( 1. ............................................................S
M .8 +    0
G .7 +    0
/ .6 +    0            0000000000000
L .4 +    000000  000000           0
) .3 +         0000                0
  .1 +                             0000000000000000000000000000000
  0. +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
     0     4     8     12    16    20    24    28    32    36    40
        2     6     10    14    18    22    26    30    34    38
                     DISTANCE DOWNSTREAM (MILES)

PLOT ZN          FOR ANOTHER TIME PERIOD ? y

TIME PERIOD ? 2
                    ZN   :  TIME PERIOD NO.  2


 1. ++
    ................................ ...... ....................S
C.9 ++
0.8 ++
N   +
C.7 ++
..6 ++
    ++
(.5 000000
M.4 ++   0
G   ++   0
/.3 +    0            0000
L.2 ++   0      0000000  0
).1 ++   000000000       000000000
    +                            0
 0. +++++++++++++++++++++++++++++00000000000000000000000000000000
    0     4     8     12    16    20    24    28    32    36    40
       2     6     10    14    18    22    26    30    34    38
                    DISTANCE DOWNSTREAM (MILES)


PLOT ZN          FOR ANOTHER TIME PERIOD ? n
PLOT ANOTHER WATER QUALITY ATTRIBUTE  ? n


*****************************************************
     THIS CONCLUDES 'WQRTV'. YOU MAY EXECUTE MORE
         RTV ROUTINES NOW, BEGIN A MITIGATION
                  LOOP OR SIGNOFF.
*****************************************************
    2.993 CP SECONDS EXECUTION TIME
```

```
/-sirtv

     ==============================================
               SAPROBIC INDEX ANALYSIS
                         FOR
             EXAMPLE NO. 1

     ==============================================

     WATER QUALITY          RIVER MILES IN TIME PERIOD
      DESIGNATION         1     2     3     4     5     6
     -------------      ----- ----- ----- ----- ----- -----

   PUREST WATER          0.0   0.0
   CLEAN WATER           3.2  26.5
   MILD POLLUTION        2.5   0.0
   POLLUTED              6.8   0.0
   HEAVILY POLLUTED     14.0  10.9
   RAW SEWAGE           13.5   2.7
   SEPTIC CONDITION      0.0   0.0
     -------------      ----- ----- ----- ----- ----- -----

     DO YOU WANT FURTHER QUANTIFICATION OF THIS
          (ANS: YES OR NO) ? y

     INPUT TIME PERIOD OF INTEREST ? 1

     THIS SECTION ISN'T OPERATIONAL YET, BUT THE
     OUTPUT WILL BE LOCATIONS OF ZONES IN EACH
     WATER QUALITY DESIGNATION FOR THE SPECIFIED
     TIME PERIOD.
     .038 CP SECONDS EXECUTION TIME
```

```
/-turtv

 LOADER INFORMATION.
    MAP OPTIONS  =  OFF
    GLOBAL LIBRARY SET IS -
 GCSALPH



 +=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+
 +     THIS RTV ROUTINE TESTS ENVIRONMENTAL TOXICITY    +
 +=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+

 ----------------------------------------------------------
      EXAMPLE NO. 1

 ----------------------------------------------------------

       ..DICATE WHICH WATER QUALITY ATTRIBUTE(S) ARE
             TO BE ANALYZED FOR THEIR TOXIC EFFECTS.
           1)  TEMP.            5)  NO2
           2)  BOD5             6)  NO3
           3)  TSS              7)  PO4
           4)  NH3              8)  D.O.
                     9)  HARD.
                    10)  PH
                    11)  ZN
                    12)  CL2
                    13)  COLI.
      RESPOND WITH THE TOTAL NUMBER OF TOXICANTS
           FOLLOWED BY THE APPROPRIATE INDEX NUMBERS
      ? 3,4,11,12

      SPECIFY TARGET SPECIES:

      DESIGNATE STREAM TYPE (W=WARM WATER,C=COLD WATER) ? w

      REPRESENTATIVE SPECIES LIST:
         1)  FATHEAD MINNOW
         2)  CARP
         3)  BLUEGILL
         4)  CHANNEL CAT
         5)  LARGEMOUTH BASS
      RESPOND WITH NUMBER OF TARGET SPECIES DESIRED AND
           WITH THEIR APPROPRIATE INDEX NUMBER(S).
      ? 1,3

      INPUT THE 96 HOUR LC50'S FOR THE FOLLOWING SPECIES
           AND POTENTIONAL TOXICANTS:

      BLUEGILL
           NH3          ? .6
           ZN           ? 8.
           CL2          ? .2

      SPECIFY TIME PERIOD OF INTEREST ? 1
```

```
-------------------------------------------------------
   REPORT ON TOXICITY IMPACTS IN TIME PERIOD 1
-------------------------------------------------------


     MAXIMUM AND MEAN (IN PARENTHESES) TOXICITY UNITS

                                    TOXICANT
  TARGET SPECIES         TOTAL      NH3        ZN        CL2
BLUEGILL                28.136   22.238      .250     7.177
                       ( 4.272) ( 4.272) (   .054) ( 2.903) (




     DO YOU WANT A GRAPHICAL OUTPUT FOR TOXICITY UNITS
          VS. LOCATION DOWNSTREAM (ANS: YES OR NO) ? y


     INPUT TOXICANT NUMBER ?
     1)  NH3
     2)  ZN
     3)  CL2
     ? 1

     INPUT TARGET SPECIES INDEX  ? 1


              BLUEGILL            ; NH3   ; TIME PERIOD  1
          (T=TOTAL T.U.'S;  *=T.U.'S FROM SPECIFIED ATT.)


 30 ..
 28 ..         T
 26 ..         TT
T24 ..         TT
O22 ..         T TT
X20 ..         T* TT
.18 ..         T**  TT
 16 ..         T  *   TT
U14 T.         T   **   T
N12 .TT        T     **  TTTT
I 8 ..TT TTT   T       **   TTTTTTT
T 6 ..  TT TTTTT        *****      TTT
S 4 ..   *     *            *******  T
  2 ..   *     *                   **TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT
  0 .....*******.....................***********************************
    0     4      8     12      16    20     24    28     32     36    40
       2      6     10     14     18     22    26     30    34     38
                      DISTANCE DOWNSTREAM (MILES)

     PLOT TOXICITY IMPACTS FROM NH3
          FOR ANOTHER TARGET SPECIES ? n
     PLOT FOR ANOTHER TOXICANT ? y
```

```
INPUT TOXICANT NUMBER ? 2

INPUT TARGET SPECIES INDEX  ? 1


          BLUEGILL              ; ZN     ; TIME PERIOD  1
      (T=TOTAL T.U.'S;  *=T.U.'S FROM SPECIFIED ATT.)


 30 ..
 28 ..         T
 26 ..         TT
T24 ..         TT
O22 ..         T TT
X20 ..         T  TT
.18 ..         T    TT
 16 ..         T      TT
U14 T.         T        T
N12 .TT        T         TTTT
I 8 ..TT TTT   T            TTTTTTT
T 6 ..  TT TTTTT                   TTT
S 4 ..                               T
  2 ..                               TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT
  0 *********************************************************************
    0     4      8     12     16     20     24     28     32     36    40
       2      6      10     14     18     22     26     30     34     38
                   DISTANCE DOWNSTREAM (MILES)

PLOT TOXICITY IMPACTS FROM ZN
     FOR ANOTHER TARGET SPECIES ? n
PLOT FOR ANOTHER TOXICANT ? y

INPUT TOXICANT NUMBER ? 3

INPUT TARGET SPECIES INDEX  ? 1


          BLUEGILL              ; CL2    ; TIME PERIOD  1
      (T=TOTAL T.U.'S;  *=T.U.'S FROM SPECIFIED ATT.)


 30 ..
 28 ..         T
 26 ..         TT
T24 ..         TT
O22 ..         T TT
X20 ..         T  TT
.18 ..         T    TT
 16 ..         T      TT
U14 T.         T        T
N12 .TT        T         TTTT
I 8 ..TT TTT   T            TTTTTTT
T 6 ..  TT*TTTTT*********          TTT
S 4 ..   *          *************T
  2 ..   *                         TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT
  0 ******...........................************************************
    0     4      8     12     16     20     24     28     32     36    40
       2      6      10     14     18     22     26     30     34     38
                   DISTANCE DOWNSTREAM (MILES)
```

```
PLOT TOXICITY IMPACTS FROM CL2
     FOR ANOTHER TARGET SPECIES ? n
PLOT FOR ANOTHER TOXICANT ? n



DO YOU WISH TO CONTINUE ANALYSES FOR ANOTHER TIME
     PERIOD (ANS: Y OR N) ? y

SPECIFY TIME PERIOD OF INTEREST ? 2


------------------------------------------------------------
   REPORT ON TOXICITY IMPACTS IN TIME PERIOD 2
------------------------------------------------------------


     MAXIMUM AND MEAN (IN PARENTHESES) TOXICITY UNITS

                                        TOXICANT
   TARGET SPECIES          TOTAL      NH3        ZN        CL2
 BLUEGILL                  41.276   10.394      .060     2.727
                         ( -.114) ( 2.114) (   .015) (   .826) (



     DO YOU WANT A GRAPHICAL OUTPUT FOR TOXICITY UNITS
          VS. LOCATION DOWNSTREAM (ANS: YES OR NO) ? y

     INPUT TOXICANT NUMBER ? 1

     INPUT TARGET SPECIES INDEX  ? 1


              BLUEGILL               ; NH3   ; TIME PERIOD  2
         (T=TOTAL T.U.'S;  *=T.U.'S FROM SPECIFIED ATT.)


  42.5 .
   40. .         T
  37.5 .         TTT
 T 35. .         T  TT
 032.5 .         T   T
 X27.5 .         T    TT
 . 25. .         T     TTT
  22.5 .         T        TT
 U120. .         T         TTTT
 N 15. TT        T             T
 I12.5 . TT      T             TTTT
 T 10. .   TTTTTTT****             TTTTTT
 S 7.5 .         *   **********         T
   2.5 ******    *             *******  T
    0. .....******...................**TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT
       0     4      8      12    16    20     24     28     32    36    40
          2     6      10     14    18     22     26     30    34    38
                            DISTANCE DOWNSTREAM (MILES)

     PLOT TOXICITY IMPACTS FROM NH3
          FOR ANOTHER TARGET SPECIES ? n
     PLOT FOR ANOTHER TOXICANT ? y
```

```
INPUT TOXICANT NUMBER ? 2

INPUT TARGET SPECIES INDEX  ? 1


          BLUEGILL            ; ZN     ; TIME PERIOD  2
     (T=TOTAL T.U.'S;  *=T.U.'S FROM SPECIFIED ATT.)


 42.5 .
  40. .         T
 37.5 .         TTT
T 35. .         T  TT
032.5 .         T   T
X27.5 .         T    TT
. 25. .         T     TTT
 22.5 .         T        TT
U120. .         T         TTTT
N 15. TT        T            T
I12.5 . TT      T            TTTT
T 10. .   TTTTTTT                TTTTTT
S 7.5 .                               T
  2.5 .                               T
   0. ********************************TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT
      0     4      8      12     16     20     24     28     32     36     40
         2      6      10     14     18     22     26     30     34     38
                     DISTANCE DOWNSTREAM (MILES)

PLOT TOXICITY IMPACTS FROM ZN
     FOR ANOTHER TARGET SPECIES ? n
PLOT FOR ANOTHER TOXICANT ? y

INPUT TOXICANT NUMBER ? 3

INPUT TARGET SPECIES INDEX  ? 1


          BLUEGILL            ; CL2    ; TIME PERIOD  2
     (T=TOTAL T.U.'S;  *=T.U.'S FROM SPECIFIED ATT.)


 42.5 .
  40. .         T
 37.5 .         TTT
T 35. .         T  TT
032.5 .         T   T
X27.5 .         T    TT
. 25. .         T     TTT
 22.5 .         T        TT
U120. .         T         TTTT
N 15. TT        T            T
I12.5 . TT      T            TTTT
T 10. .   TTTTTTT                TTTTTT
S 7.5 .                               T
  2.5 .    *******************        T
   0. ******.................*********TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT
      0     4      8      12     16     20     24     28     32     36     40
         2      6      10     14     18     22     26     30     34     38
                     DISTANCE DOWNSTREAM (MILES)

PLOT TOXICITY IMPACTS FROM CL2
     FOR ANOTHER TARGET SPECIES ? n
PLOT FOR ANOTHER TOXICANT ? n
```

```
DO YOU WISH TO CONTINUE ANALYSES FOR ANOTHER TIME
     PERIOD (ANS: Y OR N) ? n



================================================
     THIS CONCLUDES 'TURTV'. YOU MAY EXECUTE MORE
         RTV ROUTINES NOW, BEGIN A MITIGATION
                 LOOP OR SIGNOFF.
================================================
    2.004 CP SECONDS EXECUTION TIME



bye

3KVN9RS  COSTS:    690.570 SRUS AT $.0068 = $4.70
```

APPENDIX C:

RIAS SOURCE PROGRAMS

```
type,rias/g

NOTE.!   ************************************************************
NOTE.!   *                                                          *
NOTE.!   *                 WELCOME TO THE                           *
NOTE.!   *          RATIONAL IMPACT EVALUATION SYSTEM               *
NOTE.!   *                                                          *
NOTE.!   *                 U.S.A.C.E.                               *
NOTE.!   *        CONSTRUCTION ENGINEERING RESEARCH                 *
NOTE.!   *                 LABORATORY                               *
NOTE.!   *                                                          *
NOTE.!   *                 VERSION 1.2                              *
NOTE.!   *                 NOVEMBER 1979                            *
NOTE.!   *                                                          *
NOTE.!   ************************************************************
NOTE.!!
NOTE.!!
NOTE.!!
NOTE.!        THIS COMPUTER BASED IMPACT ASSESSMENT SYSTEM
NOTE.!        CAN BE ACTIVATED BY EXECUTING A SERIES OF
NOTE.!        PROCEDURE FILES WHICH ARE DESCRIBED BELOW:
NOTE.!!
NOTE.!   1)   -FQUES
NOTE.!!
NOTE.!        THIS PROC FILE EXECUTES A PROGRAM WHICH ASKES
NOTE.!        A SERIES OF QUESTIONS ABOUT THE ENVIRONMENTAL
NOTE.!        SETTING FOR A SPECIFIC PROJECT AND ORGANIZES
NOTE.!        THE INFORMATION OBTAINED INTO A DATA FILE
NOTE.!        WHICH IS USED AS INPUT FOR SIMULATIONS AND
NOTE.!        OTHER EVALUTION PROTOCOLS.  'FQUES' CAN BE
NOTE.!        USED TO SETUP A NEW DATA FILE OR TO REVISE
NOTE.!        AN EXISTING DATA FILE.  OUTPUT FROM 'FQUES'
NOTE.!        IS TO A MASS STORAGE FILE CALLED 'TAPE9'.
NOTE.!!
NOTE.!   2)   -SIMWQ
NOTE.!!
NOTE.!        THIS PROC FILE EXECUTES A WATER QUALITY
NOTE.!        SIMULATION MODEL WHICH PREDICTS PRIMARY
NOTE.!        PHYSICAL AND CHEMICAL IMPACTS IN THE AQUATIC
NOTE.!        ENVIRONMENT BASED OF THE ENVIRONMENTAL
NOTE.!        SETTING AND PROJECT SPECIFICATION INFORMA-
NOTE.!        TION STORED IN THE OUTPUT FROM 'FQUES'.
NOTE.!        OUTPUT FROM 'SIMWQ' IS TO A MASS STORAGE
NOTE.!        FILE CALLED 'TAPE33'.
NOTE.!!
NOTE.!   3)   -RTVS
NOTE.!!
NOTE.!        THIS PROC CALLS A LISTING OF A SERIES OF
NOTE.!        PROGRAMS WHICH QUANTIFY ENVIRONMENTAL IMPACTS
NOTE.!        IN THE AQUATIC ECOSYSTEM.  THE USER CAN
NOTE.!        THEN CHOOSE WHICH RTV MODELS ARE APPLICABLE
NOTE.!        AND CAN EXECUTE EACH WITH THE APPROPRIATE
NOTE.!        PROC CALL.  ALL RTV MODELS REQUIRE INPUT
NOTE.!        FROM 'TAPE9' AND/OR 'TAPE33'.
NOTE.!!
NOTE.!   **********  YOU MAY BEGIN  ************
NOTE.!!
/
```

```
 type,-fques/g

GET,BFQUES/ID=341447562.
RWF.
BFQUES.
NOTE.!!
NOTE.!!
NOTE.!!
NOTE.!!
NOTE.!      YOUR DATA SET IS STORED IN THE FILE 'TAPE9'.
NOTE.!      REMEMBER TO SAVE OR REPLACE IT IF YOU WANT TO
NOTE.!      USE IT IN A LATER SESSION.
NOTE.!!
/
```

```
 type,simwq/g
NOTE.!!
NOTE.!!
NOTE.!!
NOTE.!                SIMULATIONS HAVE BEEN STARTED
NOTE.!                  USING THE FILE 'TAPE9' AS
NOTE.!                       CONTROL INPUT.
GET,BSIMWQ/ID=341447562.
RWF.
BSIMWQ.
NOTE.!!
NOTE.!!
NOTE.!!
NOTE.!!
NOTE.!      WATER QUALITY SIMULATIONS COMPLETE.
NOTE.!      YOU MAY NOW PROCEED TO RTV TESTING.
NOTE.!      REMEMBER TO SAVE OR REPLACE 'TAPE33' IF
NOTE.!      YOU PLAN TO USE IT IN LATER SESSONS.
NOTE.!!
/
```

```
 type,rtvs/g

NOTE.!          THE FOLLOWING RATIONAL THRESHOLD EVALUATIONS
NOTE.!          MAY BE INITIATED AT THIS TIME BY EXECUTION OF
NOTE.!          OF THE APPROPRIATE 'PROC' FILES:
NOTE.!!
NOTE.!                     -WQRTV
NOTE.!                            ASSESSMENT OF OVERALL WATER QUALITY IMPACTS.
NOTE.!                     -SIRTV
NOTE.!                            ASSESSMENT OF IMPACTS OF ORGANIC ENRICHMENT.
NOTE.!                     -TURTV
NOTE.!                            ASSESSMENT OF ENVIRONMENTAL TOXICITY IMPACTS.
NOTE.!!
NOTE.!          REMEMBER TO HAVE 'TAPE9' AND 'TAPE33' AVAILABLE
NOTE.!          AS LOCAL FILES BEFORE EXECUTION.
NOTE.!!
/
```

```
type,turtv/g

GET,BTURTV/ID=341447562.
RWF.
GRAB,GCSALPH/F.
BTURTV.
/
```

```
 ytpe *DEL*
type,sturtv/g
```

```
type,wqrtv/g

GET,BWQRTV/ID=341447562.
GRAB,GCSALPH/F.
RWF.
BWQRTV.
/
```

```
type,sirtv/g

GET,BSIRTV/ID=341447562.
RWF.
BSIRTV.
/
```

```
      PROGRAM FILTERQ(INPUT,OUTPUT,TAPE1=INPUT,TAPE2=OUTPUT,TAPE9)
      COMMON/NAMES/TITLE(8),CNAME(20),SNAME(20),KNAME(20)
      COMMON/CNTRL/NR,NTP,NWQC,NB,NIT,NIE,IT(15),IE(15),HCODE,
     + MCODE(8),NCWQC,NNCWQC,NTWQC,NS,NK
      COMMON/IWQC/TWQ(15,20),EWQ(15,20),TQ(15),EQ(15)
      COMMON/KDATA/K20(20,20)
      COMMON/SDATA/S20(20,20)
      COMMON/MDATA/LR(20),DA(20),DEPTH(20),VEL(20),BCODE(15),
     + HAV(20),HBV(20),HAD(20),HBD(20)
      COMMON/BDATA/A(20)
      INTEGER TITLE,CNAME,HCODE,KNAME,SNAME
      INTEGER DINDEX(125),CNTRLS(8)
      REAL LR,K20
      DATA (CNAME(I),I=1,8)/"TEMP.","BOD5","TSS","NH3","NO2","NO3",
     + "PO4","D.O."/
      DATA (KNAME(I),I=1,20)/"KANH3","KANO3","KAPO4","KL","KLS",
     + "KNDET","KNH3","KNO2","KNO3","KPDET","KPO4","KR","KSS",
     + "KSSS","KT","KTSS","KNCA1","KNCA2","KNCA3","KNCA4"/
      DATA (SNAME(I),I=1,20)/"SL","SNH3","SNO3","SO2","SPO4",
     + "SSOD","SSS","ST","SAT1","SAT2","SAT3","SAT4","SAT5","SAT6",
     + "SAT7","SAT8","SAT9","SAT10","SAT11","SAT12"/
      PRINT*," "
      PRINT*," "
      PRINT*," "
      PRINT*,"            ##########################################"
      PRINT*,"            #                                        #"
      PRINT*,"            #            THIS PROGRAM ALLOWS         #"
      PRINT*,"            #        THE USER TO BUILD UP A NEW      #"
      PRINT*,"            #   DATA FILE OR TO REVISE AN OLD DATA   #"
      PRINT*,"            #     FILE FOR SUBSEQUENT CONTROL AND    #"
      PRINT*,"            #       INPUT FOR WATER QUALITY SIM-     #"
      PRINT*,"            #          ULATONS UNDER 'RIAS'          #"
      PRINT*,"            #                                        #"
      PRINT*,"            ##########################################"
      PRINT*," "
      PRINT*," "
      PRINT*," "
      PRINT*," "
      PRINT*," "
      CALL OPENMS(9,DINDEX,125,0)
      PRINT*,"      DO YOU WISH TO BEGIN CREATING A NEW DATA FILE"
10    PRINT*,"           (ANS: YES OR NO) ",
      READ(1,901) IANS1
      IF(EOF(1)) 10,11
11    IF(IANS1.NE."Y".AND.IANS1.NE."N") GO TO 10
      IF(IANS1.EQ."N") GO TO 500
      PRINT*," "
      PRINT*,"             ================================"
      PRINT*,"                  TIME INVARIANT PARAMETERS"
      PRINT*,"             ================================"
      PRINT*," "
      PRINT*," "
20    PRINT*,"      I)  TYPE IN THE NAME OF THE DATA SET"
      READ(1,911) (TITLE(I),I=1,8)
```

```
      IF(EOF(1)) 20,21
21    PRINT*," "
      PRINT*,"     II)  ANSWER THE FOLLOWING QUESTIONS ABOUT SIMULATION"
      PRINT*,"               CONTROL PARAMETERS."
      PRINT*," "
30    PRINT*,"          HOW MANY REACHES (ANS:1-20) ",
      READ(1,*) NR
      IF(EOF(1)) 30,31
31    PRINT*,"          HOW MANY TIME PERIODS (ANS:1-12) ",
      READ(1,*) NTP
      IF(EOF(1)) 31,32
32    PRINT*,"          HOW MANY ADDITIONAL CONSERVATIVE WATER QUALITY"
      PRINT*,"               ATTRIBUTES BEYOND THE CORE ATTRIBUTES"
      PRINT*,"               (ANS: 0-12) ",
      READ(1,*) NCWQC
      IF(EOF(1)) 32,33
33    PRINT*,"          HOW MANY ADDITIONAL NONCONSERVATIVE ATTRIBUTES"
      PRINT*,"               (ANS: 0-4) ",
      READ(1,*) NNCWQC
      IF(EOF(1)) 33,34
34    NTWQC=8+NCWQC+NNCWQC
      NWQC=8
      NK=16+NNCWQC
      NS=NTWQC
      IF(NTWQC.LE.8) GO TO 70
      PRINT*,"          INPUT THE NAMES OF THESE ADDITIONAL PARAMETERS."
      IF(NCWQC.LT.1) GO TO 51
      PRINT*,"               CONSERVATIVE ATTRIBUTES:"
      DO 50 I=1,NCWQC
49    PRINT*,"                    ATT. NO. ",I+8,")",
      READ(1,913) CNAME(8+I)
      IF(EOF(1)) 49,50
50    CONTINUE
      IF(NNCWQC.LT.1) GO TO 70
51    PRINT*,"               NONCONSERVATIVE ATTRIBUTES:"
      DO 60 I=1,NNCWQC
59    PRINT*,"                    ATT. NO. ",I+8+NCWQC,")",
      READ(1,913) CNAME(8+NCWQC+I)
      IF(EOF(1)) 59,60
60    CONTINUE
70    PRINT*,"          INPUT THE MODELING CODES FOR THE EIGHT CORE"
      PRINT*,"               ATTRIBUTES (ANS: 0 OR 1) "
      PRINT*,"
      READ(1,*) (MCODE(I),I=1,8)
      IF(EOF(1)) 70,71
71    PRINT*," "
      PRINT*,"     III)  INPUT THE PARAMETERS DESCRIBING THE WATERSHED"
      PRINT*,"               STRUCTURE FOR THIS SIMULATION."
      PRINT*," "
100   PRINT*,"               HOW MANY TRIBUTARY INPUTS ",
      READ(1,*) NIT
      IF(EOF(1)) 100,101
101   IF(NIT.LT.1) GO TO 120
      PRINT*,"                    INPUT CODES:"
      DO 111 I=1,NIT
110   PRINT*,"                     ",I,")",
      READ(1,*) IT(I)
      IF(EOF(1)) 110,111
111   CONTINUE
120   PRINT*,"               HOW MANY POINT SOURCE DISCHARGES ",
      READ(1,*) NIE
      IF(EOF(1)) 120,121
121   IF(NIE.LT.1) GO TO 141
      PRINT*,"                    INPUT CODES:"
```

```
      DO 140 I=1,NIE
130   PRINT*,"                        ",I,")",
      READ(1,*) IE(I)
      IF(EOF(1)) 130,140
140   CONTINUE
141   PRINT*,"                HOW MANY MAIN BRANCH BIFURCATIONS ",
      READ(1,*) NB
      IF(EOF(1)) 141,142
142   IF(NB.LT.1) GO TO 151
      PRINT*,"                          BIFURCATION CODES:"
      DO 150 I=1,NB
145   PRINT*,"                        ",I,")",
      READ(1,915) BCODE(I)
      IF(EOF(1)) 145,150
150   CONTINUE
151   PRINT*," "
160   PRINT*,"                INPUT THE LENGTH OF EACH REACH AND THE"
      PRINT*,"                     DRAINAGE AREA UPSTREAM FROM THE "
      PRINT*,"                     TOP OF EACH REACH (ANS: MILES AND"
      PRINT*,"                     SQUARE MILES)."
      DO 170 IR=1,NR
161   PRINT*,"                        ",IR,")",
      READ(1,*) LR(IR),DA(IR)
      IF(EOF(1)) 161,170
170   CONTINUE
      PRINT*," "
      PRINT*,"     IV)  INDICATE HOW YOU WISH TO MODEL STREAM "
      PRINT*,"          HYDRAULICS."
      PRINT*,"                0)  MEAN DEPTH AND VELOCITY SPECIFIED"
      PRINT*,"                    FOR EACH REACH AND TIME PERIOD."
      PRINT*,"                1)  HYDRAULIC RATING PARAMETERS USED FOR"
      PRINT*,"                    EACH REACH."
180   PRINT*,"                (ANS: USE EITHER 0 OR 1)",
      READ(1,914) HCODE
      IF(EOF(1)) 180,181
181   IF(HCODE.LT.1) GO TO 300
      PRINT*,"          INPUT THE HYDRAULIC RATING PARAMETERS FOR EACH"
      PRINT*,"                REACH; RESPOND WITH FOUR PARAMETERS IN "
      PRINT*,"                THE FOLLOWING ORDER: AV,BV,AD,BD."
      DO 190 I=1,NR
189   PRINT*,"                        ",I,")",
      READ(1,*) HAV(I),HBV(I),HAD(I),HBD(I)
      IF(EOF(1)) 189,190
190   CONTINUE
      PRINT*," "
300   PRINT*," "
      PRINT*," "
      CALL LOADTIP(ITP)
      DO 450 ITP=1,NTP
      PRINT*," "
      PRINT*,"======================================================"
      PRINT*,"  TIME VARIANT PARAMETERS FOR TIME PERIOD NO. ",ITP
      PRINT*,"======================================================"
      PRINT*," "
      PRINT*," "
      IF(HCODE.GT.0) GO TO 221
      PRINT*,"     I)  HYDRAULIC PARAMTERS."
      PRINT*," "
      PRINT*,"          INPUT MEAN VELOCITIES FOR EACH REACH."
210   PRINT*,"          ",
      READ(1,*) (VEL(II),II=1,NR)
      IF(EOF(1)) 210,211
211   PRINT*," "
      PRINT*,"          INPUT MEAN DEPTHS FOR EACH REACH."
```

```
220    PRINT*,"           ",
       READ(1,*) (DEPTH(II),II=1,NR)
       IF(EOF(1)) 220,221
221    PRINT*," "
       PRINT*,"      II)  BOUNDARY CONDITIONS AT TRIBUTARIES."
       PRINT*," "
       PRINT*,"           _ ..T AMBIENT WATER QUALITY CONDITIONS FOR"
       PRINT*,"           TRIBUTARIES 1 THROUGH ",NIT
       DO 225 IC=1,NTWQC
224    PRINT*,"           ",CNAME(IC),":",
       READ(1,*) (TWQ(IIT,IC),IIT=1,NIT)
       IF(EOF(1)) 224,225
225    CONTINUE
       PRINT*," "
226    PRINT*,"           MEAN DISCHARGE:",
       READ(1,*) (TQ(IIT),IIT=1,NIT)
       IF(EOF(1)) 226,227
227    PRINT*," "
       PRINT*,"      III)  BOUNDARY CONDITIONS AT EFFLUENT DISCHARGES."
       PRINT*," "
       PRINT*,"           ...UT AMBIENT WATER QUALITY CONDITIONS FOR"
       PRINT*,"           EFFLUENTS 1 THROUGH ",NIE
       DO 235 IC=1,NTWQC
234    PRINT*,"           ",CNAME(IC),":",
       READ(1,*) (EWQ(IIE,IC),IIE=1,NIE)
       IF(EOF(1)) 234,235
235    CONTINUE
       PRINT*," "
236    PRINT*,"           MEAN DISCHARGE:",
       READ(1,*) (EQ(IIE),IIE=1,NIE)
       IF(EOF(1)) 236,237
237    PRINT*," "
       PRINT*,"      IV)  REACTION RATE COEFFICIENTS."
       PRINT*," "
       PRINT*,"           INPUT THE INDICATED RATE COEFFICIENT FOR"
       PRINT*,"           REACHES 1 THROUGH ",NR
       PRINT*," "
       DO 250 IK=1,NK
249    PRINT*,"           ",KNAME(IK),
       READ(1,*) (K20(IR,IK),IR=1,NR)
       IF(EOF(1)) 249,250
250    CONTINUE
       PRINT*," "
       PRINT*,"      V)  DISTRIBUTED SOURCE/SINK PARAMETERS."
       PRINT*," "
       PRINT*,"           INPUT THE INDICATED SOURCE/SINK TERM FOR"
       PRINT*,"           REACHES 1 THROUGH ",NR
       PRINT*," "
       DO 260 IS=1,NS
259    PRINT*,"           ",SNAME(IS),
       READ(1,*) (S20(IR,IS),IR=1,NR)
       IF(EOF(1)) 259,260
260    CONTINUE
       PRINT*," "
       PRINT*,"      VI)  BIOLOGICAL PARAMETERS."
       PRINT*," "
       PRINT*,"           INPUT ESTIMATED ALGAL BIOMASS FOR REACHES"
       PRINT*,"           1 THROUGH ",NR
271    PRINT*,"           ",
       READ(1,*) (A(IR),IR=1,NR)
       IF(EOF(1)) 271,450
450    CALL LOADVPS(ITP)
       CALL CLOSMS(9)
```

```
500   PRINT*," "
      PRINT*," "
      PRINT*," "
      PRINT*," "
      PRINT*," "
      PRINT*,"     DO YOU WISH TO REVIEW AND/OR REVISE THE EXISTING"
      PRINT*,"          DATA FILE "
510   PRINT*,"          (ANS: YES OR NO)",
      READ(1,901) IANS2
      IF(EOF(1)) 510,511
511   IF(IANS2.NE."Y".AND.IANS2.NE."N") GO TO 510
      IF(IANS2.EQ."N") GO TO 898
      IF(IANS1.EQ."N") GO TO 519
      CALL OPENMS(9,DINDEX,125,0)
519   CALL UNLOAD(ITP)
520   PRINT*," "
      PRINT*," "
600   CALL DSUM
901   FORMAT(1A1)
902   FORMAT(1I1)
903   FORMAT(8A10)
911   FORMAT(8A10)
913   FORMAT(1A5)
914   FORMAT(1I1)
915   FORMAT(1F5.2)
923   FORMAT(8F10.3)
898   CONTINUE
999   STOP
*****************************************************************************
*        INDEX FOR ALL VARIABLES AND PARAMETERS USED IN 'SIMWQ'            *
*                                                                          *
*   A(IR)          ALGAL CONCENTRATIONS IN REACH 'IR' (MG/L)               *
*   ALPHA(IC)      PARAMETER FOR ANALYTICAL WQ SOLUTION (MG/L)             *
*   ATT            KEY FOR MASS STORAGE OF WQ VECTOR                       *
*   BCODE(IB)      BIFURACTION CODE DEFINING WATERSHED BRANCHES            *
*   BETA(IC,I)     PARAMETER FOR ANALYTICAL WQ SOLUTION (MG/L)             *
*   BQ(IB)         DISCHARGE AT MINOR TRIBUTARY AT IB'TH                   *
*                          BIFURCATION (FT**3/SEC)                         *
*   BWQ(IB,IC)     WQ VECTOR AT MINOR TRIBUTARY AT IB'TH BIFURCATION       *
*   CNAME(IC)      ALPHABETIC NAMES OF WATER QUALITY ATTIBUTES             *
*   CNTRLS(8)      ARRAY HOLDING SIMULATION CONTROL PARAMETERS FOR         *
*                       TRANSFER TO AND FROM MASS STORAGE                  *
*                       (NR,NTP,NTWQC,ETC.)                                *
*   DA(IR)         DRAINAGE AREA UPSTREAM FROM IR'TH REACH (MILES**2)      *
*   DELTA(IC,I)    PARAMETER FOR ANALYTICAL WQ SOLUTION                    *
*   DEPTH(IR)      MEAN DEPTH OF IR'TH REACH (FEET)                        *
*   DINDEX(I)      MASTER INDEX FOR MASS STORAGE OF SIMULATION DATA        *
*   EPSIL(IC,I)    PARAMETER FOR ANALYTICAL WQ SOLUTION                    *
*   EQ(IE)         DISCHARGE AT IE'TH POINT SOURCE EFFLUENT INPUT (FT*3/SEC) *
*   EWQ(IE,IC)     WATER QUALITY VECTOR AT IE'TH EFFLUENT INPUT            *
*   GAMMA(IC,I)    PARAMETER FOR ANALYTICAL WQ SOLTIONS                    *
*   HAD(IR)        HYDRAULIC RATING PARAMETER FOR MEAN DEPTHS              *
*   HAV(IR)        HYDRAULIC RATING PARAMETER FOR MEAN VELOCITIES          *
*   HBD(IR)        HYDRAULIC RATING PARAMETER FOR MEAN DEPTHS              *
*   HBV(IR)        HYDRAULIC RATING PARAMETER FOR MEAN VELOCITIES          *
*   HCODE          SWITCH FOR SPECIFYING MODELING CHOICE FOR DEPTH   VEL   *
*   IATT           ATTRIBUTE INDEX (1 TO 20)                               *
*   IB             BIFURACTION INDEX (1 TO 5)                              *
*   IC             WQ CONSTITUENT INDEX (1 TO 20); SAME AS IATT            *
*   IE(IIE)        EFFLUENT INPUT INDEX (1 TO 15)                          *
*   INUM           INDEX FOR SPECIFICATION OF RECORD KEY FOR MASS STORAGE  *
*                       OF WQ VECTORS                                      *
*   IP             SAME AS IPP                                             *
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*   IPP            INDEX OF PROFILE POINT IN SIMULATION RESULTS (1 TO 200)         *
*   IR             INDEX OF REACH (1 TO 20)                                        *
*   IREC           RECORD KEY INDEX FOR MASS STORAGE OUTPUT OF WQ VECTOR           *
*   IRECIP         INDEX OF RECIEVING REACH (DOWNSTREAM) OF IB'TH BIFUCATION       *
*   IT(IIT)        INDEX OF INPUT LOCATION OF TRIBUTARIES                          *
*   ITOP           INDEX SPECIFYING TOP OF SUPERIOR CHANNEL BRANCHES               *
*   ITP            INDEX OF TIME PERIOD (1 TO 12)                                  *
*   IWQC           INDEX OF WATER QUALITY CONSTITUENTS (1 TO 20)                   *
*   KT             TEMPERATURE ADJUSTED KINETIC RATE COEFFICIENT (1/DAY)           *
*   K20            KINETIC RATE COEFFICIENT AT 20 DEGREES C (1/DAY)                *
*   LR(IR)         LENGTH OF IR'TH REACH (MILES)                                   *
*   MCODE(IC)      MODELING CODE FOR IC'TH ATTRIBUTE                               *
*   NAATTS         NUMBER OF WQ ATTRIBUTES                                         *
*   NB             NUMBER OF BIFURCATIONS OF STREAM CHANNEL (0<NB<5)               *
*   NCWQC          NUMBER OF CONSERVATION WQ CONSITUENTS (0<NCWQC<12-NNCWQC)       *
*   NIE            NUMBER OF POINT SOURCE EFFLUENT INPUTS (0<NIE<15)               *
*   NIT            NUMBER OF TRIBUTARY INPUTS (1<NIT<15)                           *
*   NK             NUMBER OF RATE COEFFICIENTS NECESSARY FOR SIMULATION            *
*   NNCWQC         NUMBER OF NON-CONSERVATION WQ CONSTITUENTS                      *
*   NPP            NUMBER OF PROFILE POINTS IN SIMULATION OF CURRENT               *
*   NR             NUMBER OF REACHES IN CURRENT SIMULATION (1<NR<20)               *
*   NS             NUMBER OF SOURCE/SINK TERMS IN SIMULATION (0<NS<20)             *
*   NTP            NUMBER OF TIME PERIODS IN SIMULATION RUN (1<NTP<12)             *
*   NTWQC          NUMBER OF TOTAL WQ CONSTITUENTS IN SIMULATION (NTWQC<20)        *
*   NWQC           NUMBER OF CORE WATER QUALTIY CONSTITUENTS IN SIMULATION         *
*   PN             PERCENT OF NITROGEN IN SUSPENDED SOLIDS (%/100)                 *
*   PP             PERCENT OF PHOSPHORUS IN SUSPSENDED SOLIDS (%/100)              *
*   Q(IPP)         STREAM DISCHARGE AT IPP'TH POINT OF OUTPUT PROFILE (FT**3/SEC*
*   QB             DISCHARGE INPUT FROM BIFURCATION TO CURRENT REACH (CFS)         *
*   QE             DISCHARGE INPUT FROM TRIBUTARIES TO CURRENT REACH (CFS)         *
*   QINDEX(I)      MASTER INDEX FOR MASS STORAGE OF SIMULATED WQ PROFILES          *
*   QT             DISCHARGE INPUT FROM TRIBUTARIES TO CURRENT REACH (CFS)         *
*   Q0             DISCHARGE AT TOP OF CURRENT REACH AFTER DILUTIONS (CFS)         *
*   Q10K(IK)       TEMPERATURE CORRECTION FACTOR FOR IK'TH RATE COEFFICIENT        *
*   Q10S(IS)       TEMPERATURE CORRECTION FACTOR FOR IS'TH SOURCE/SINK TERM        *
*   ST(IR,IS)      TEMPERATURE CORRECTED SOURCE/SINK TERM FOR IR'TH REACH          *
*   S20(IR,IS)     SOURCE/SINK TERM AT 20 DEGREES C (MG/L/DAY)                     *
*   TEMP           WATER TEMPERATURE (DEGREES C)                                   *
*   TITLE(8)       SIMULATION NAME                                                 *
*   TLR            TOTAL LENGTH OF STREAM TO BE SIMULATED (MILES)                  *
*   TQ(IT)         DISCHARGE IN IT'TH TRIBUTARY (CFS)                              *
*   TTWR           TOTAL TIME OF TRAVEL WITHIN CURRENT REACH (DAYS)                *
*   TWQ(IT,IC)     WATER QUALITY VECTOR FOR IT'TH TRIBUTARY INPUT                  *
*   VEL(IR)        MEAN VELOCITY IN IR'TH REACH (MILES/DAY)                        *
*   WQ(IPP)        WATER QUALITY VECTOR AT IPP'TH POINT IN SIMULATION              *
*   WQB(IB,IC)     WATER QUALITY VECTOR FOR IB'TH BIFURCATION INPUT                *
*   WQE(IE,IC)     WATER QUALITY VECTOR FOR IE'TH EFFLUENT INPUT                   *
*   WQT(IT,IC)     WATER QUALITY VECTOR FOR IT'TH TRIBUTARY INPUT                  *
*   WQ0(IC)        WATER QUALITY VECTOR AT TOP OF CURRENT REACH AFTER              *
*   X(IPP,3)       DISTANCE ARRAY SPECIFING DISTANCE DOWNSTREAM, REACH             *
*   XIB            INDEX OF LOCATION ON WATERSHED BRANCHES                         *
*   XINC           INCREMENT BETWEEN PROFILE POINTS IN SIMULATION OUTPUT           *
*   XIR            INDEX OF LOCATION IN TERMS OF STREAM REACH                      *
*   XLAST          DISTANCE AT TOP OF CURRENT REACH                                *
*   XWR            DISTANCE FROM TOP OF CURRENT REACH                              *
*   ZETA           PARAMETER FOR ANALYTICAL WQ SOLUTION                            *
*                                                                                  *
************************************************************************************
      END
```

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C=====================================================================
      SUBROUTINE DSUM
C=====================================================================
      COMMON/NAMES/TITLE(8),CNAME(20),SNAME(20),KNAME(20)
      COMMON/CNTRL/NR,NTP,NWQC,NB,NIT,NIE,IT(15),IE(15),HCODE,
     + MCODE(8),NCWQC,NNCWQC,NTWQC,NS,NK
      COMMON/IWQC/TWQ(15,20),EWQ(15,20),TQ(15),EQ(15)
      COMMON/KDATA/K20(20,20)
      COMMON/SDATA/S20(20,20)
      COMMON/MDATA/LR(20),DA(20),DEPTH(20),VEL(20),BCODE(15),
     + HAV(20),HBV(20),HAD(20),HBD(20)
      COMMON/BDATA/A(20)
      REAL K20,LR
      INTEGER TITLE,CNAME,HCODE,KNAME,SNAME
      INTEGER TINPUT,EINPUT,START
      PRINT*," "
      PRINT*,"======================================================="
      PRINT*,"      REVIEW OF CONTENTS OF CURRENT DATA FILE"
      PRINT*,"======================================================="
      PRINT*," "
      PRINT*,"      THE CURRENT CONTENTS OF YOUR DATA FILE HAVE THE"
      PRINT*,"           TITLE:"
      PRINT*," "
      PRINT*,"      ",(TITLE(I),I=1,5)
      PRINT*,"      ",(TITLE(I),I=6,8)
      PRINT*," "
      PRINT*,"      THIS DATA SET SPECIFIES SIMULATION OF THE"
      PRINT*,"           FOLLOWING WATER QUALITY ATTRIBUTES:"
      PRINT*,"      ",(CNAME(I),I=1,5)
      PRINT*,"      ",(CNAME(I),I=6,10)
      IF(NTWQC.LT.11) GO TO 10
      PRINT*,"      ",(CNAME(I),I=11,15)
      IF(NTWQC.LT.16) GO TO 10
      PRINT*,"      ",(CNAME(I),I=16,20)
10    PRINT*," "
      PRINT*,"      SIMULATIONS WILL BE RUN FOR ",NTP," TIME PERIODS"
      PRINT*,"          FOR A TOTAL OF ",NR," STREAM REACHES."
      CALL WAIT
      PRINT*,"      THE SIMPLIFIED WATERSHED STRUCTURE IS AS FOLLOWS:"
      PRINT*," "
      PRINT*,"      REACH      LENGTH      DRAINAGE           INPUTS"
      PRINT*,"       NO.        (MI.)      (SQ.MI.)        EFF.    TRIB."
      PRINT*," "
      DO 30 IR=1,NR
      TINPUT=" "
      EINPUT=" "
      DO 23 IIT=1,NIT
      IF(IT(IIT).EQ.IR) TINPUT=IT(IIT)
23    CONTINUE
      DO 26 IIE=1,NIE
      IF(IE(IIE).EQ.IR) EINPUT=IE(IIE)
26    CONTINUE
30    PRINT(1,900) IR,LR(IR),DA(IR),EINPUT,TINPUT
 900  FORMAT(7X,1I2,3X,2(1F10.3,2X),7X,1I2,6X,1I2)
      PRINT*," "
      PRINT*,"      THE NUMBER OF MAJOR BIFURCATIONS OF THE MAIN"
      PRINT*,"           CHANNEL OF THIS RECIEVING STREAM IS ",NB
      IF(NB.LE.0) GO TO 40
      START=1
      PRINT*," "
      DO 39 INB=1,NB
      IEND=BCODE(INB)*100-IFIX(BCODE(INB))*100
      PRINT*,"      BRANCH NO. ",INB," INCLUDES REACHES ",START," TO ",
     + IEND
```

```
39      START=IEND+1
        PRINT*," "
        PRINT*,"      THE MAIN CHANNEL INCLUDES REACHES ",START," TO ",NR
        CALL WAIT
40      IF(HCODE.GT.0) GO TO 50
        PRINT*,"      HYDRAULIC MODELING WILL BE DONE USING MEAN "
        PRINT*,"           VELOCITIES AND DEPTHS FOR EACH REACH AND TIME"
        PRINT*,"           PERIOD."
        GO TO 60
50      PRINT*,"      HYDRAULIC MODELLING WILL BE DONE USING HYDRAULIC "
        PRINT*,"           RATING PARAMETERS RELATING MEAN VELOCITY AND "
        PRINT*,"           DEPTHS TO DISCHARGE IN A REACH."
60      CONTINUE
        PRINT*," "
        PRINT*,"      NONE OF THE ABOVE PARAMTERS CAN BE ALTERED WITHOUT"
        PRINT*,"           CREATING A TOTALLY NEW DATA SET (I.E., BY"
        PRINT*,"           STARTING OVER WITH 'FQUES')."
        PRINT*," "
70      PRINT*,"      DO YOU WANT TO CONTINUE (ANS: YES OR NO)",
        READ(1,901) IANS
 901    FORMAT(1A1)
        IF(EOF(1)) 70,71
71      IF(IANS.NE."Y".AND.IANS.NE."N") GO TO 70
        IF(IANS.EQ."Y") GO TO 100
        RETURN
100     PRINT*," "
        PRINT*,"      WHICH TIME PERIOD DO YOU WANT TO REVIEW",
        READ(1,*) ITP
        IF(EOF(1)) 100,101
        IF(ITP.LT.0.OR.ITP.GT.NTP) GO TO 100
101     CALL UNLTVPS(ITP)
        PRINT*," "
110     PRINT*,"      INDICATE WHICH OF THE FOLLOWING PARAMETERS YOU"
        PRINT*,"           WANT TO REVIEW (RESPOND WITH THE PROPER NUMBER)"
113     PRINT*,"                1)  HYDRAULIC PARAMETERS"
        PRINT*,"                2)  INITIAL CONDITIONS IN TRIBUTARIES"
        PRINT*,"                3)  INITIAL CONDITIONS IN EFFLUENTS"
        PRINT*,"                4)  KINETIC PARAMETERS"
        PRINT*,"                5)  DISTRIBUTED SOURCE/SINK PARAMETERS"
        PRINT*,"                6)  BIOLOGICAL PARAMETERS"
111     PRINT*,"                ",
        READ(1,*) IPARAM
        IF(EOF(1)) 111,112
112     IF(IPARAM.LT.1.OR.IPARAM.GT.6) GO TO 111
        GO TO (150,200,250,300,350,400),IPARAM
150     PRINT*," "
        IF(HCODE.NE.1) GO TO 151
        PRINT*,"      THIS DATA SET USES HYDRAULIC RATING PARAMETERS"
        PRINT*,"            THEREFORE NO MEAN VALUES FOR VELOCITY"
        PRINT*,"           OR DEPTH ARE NEEDED."
        PRINT*," "
        GO TO 500
151     PRINT*,"      THE CURRENT VALUES FOR MEAN VELOCITIES AND DEPTHS"
        PRINT*,"           FOR EACH REACH DURING TIME PERIOD ",ITP," ARE"
        PRINT*,"           LISTED BELOW.  TO CHANGE THE CURRENT VALUES"
        PRINT*,"           RESPOND TO TRAILING '?' BY THE NEW VALUES."
        PRINT*,"           (NO. REACH,VELOCITY,DEPTH)"
        DO 170 IR=1,NR
        PRINT*,"                 ",IR,")  ",VEL(IR),DEPTH(IR),
        READ(1,*) VEL(IR),DEPTH(IR)
        IF(EOF(1)) 169,170
169     CONTINUE
170     CONTINUE
```

```
      GO TO 500
200   PRINT*," "
      PRINT*,"     INDICATE WHICH WATER QUALITY ATTRIBUTE YOU ARE"
      PRINT*,"             INTERESTED IN:"
209   DO 210 IC=1,NTWQC
210   PRINT*,"                    ",IC,")  ",CNAME(IC)
      PRINT*,"                    ",NTWQC+1,")  DISCHARGE"
      PRINT*,"              ",
211   READ(1,*) IWQC
      IF(EOF(1)) 211,212
212   IF(IWQC.EQ.NTWQC+1) GO TO 230
      PRINT*,"     THE VALUES FOR ",CNAME(IWQC)," FOR TIME PERIOD "
      PRINT*,"             ",ITP," ARE LISTED BELOW BY TRIBUTARY."
      PRINT*,"             TO CHANGE A VALUE RESPOND TO THE TRAILING '?'"
      PRINT*,"             WITH THE NEW VALUE."
      DO 220 IIT=1,NIT
      PRINT*,"                    ",IIT,")  ",TWQ(IIT,IWQC),
      READ(1,*) TWQ(IIT,IWQC)
      IF(EOF(1)) 220,219
219   CONTINUE
220   CONTINUE
      PRINT*," "
      GO TO 241
230   PRINT*,"     THE VALUES FOR TRIBUTARY DISCHARGE FOR TIME PERIOD",
      PRINT*,"             ",ITP," ARE LISTED BY TRIBUTARY BELOW.  TO"
      PRINT*,"             CHANGE A VALUE RESPOND TO THE TRAILING '?' BY"
      PRINT*,"             THE NEW VALUE."
      DO 240 IIT=1,NIT
      PRINT*,"                    ",IIT,")  ",TQ(IIT),
      READ(1,*) TQ(IIT)
      IF(EOF(1)) 239,240
239   CONTINUE
240   CONTINUE
241   PRINT*," "
      PRINT*,"     REVIEW ANOTHER TRIBUTARY ATTRIBUTE (ANS: YES OR NO)",
      READ(1,901) IANS4
      IF(EOF(1)) 241,242
242   IF(IANS4.NE."N".AND.IANS4.NE."Y") GO TO 241
      IF(IANS4.EQ."N") GO TO 500
243   PRINT*,"     WHICH ATTRIBUTE",
      READ(1,*) IWQC
      IF(EOF(1)) 243,244
244   IF(IWQC.LT.1.OR.IWQC.GT.NTWQC+1) GO TO 209
      GO TO 212
250   PRINT*," "
      PRINT*,"     INDICATE WHICH WATER QUALITY ATTRIBUTE YOU ARE"
      PRINT*,"             INTERESTED IN:"
259   DO 260 IC=1,NTWQC
260   PRINT*,"          .         ",IC,")  ",CNAME(IC)
      PRINT*,"                    ",NTWQC+1,")  DISCHARGE"
      PRINT*,"              ",
261   READ(1,*) IWQC
      IF(EOF(1)) 261,262
262   IF(IWQC.EQ.NTWQC+1) GO TO 280
      PRINT*,"     THE VALUES FOR ",CNAME(IWQC)," FOR TIME PERIOD "
      PRINT*,"             ",ITP," ARE LISTED BELOW BY EFFLUENT."
      PRINT*,"             TO CHANGE A VALUE RESPOND TO THE TRAILING '?'"
      PRINT*,"             WITH THE NEW VALUE."
      DO 270 IIE=1,NIE
      PRINT*,"                    ",IIE,")  ",EWQ(IIE,IWQC),
      READ(1,*) EWQ(IIE,IWQC)
      IF(EOF(1)) 270,269
269   CONTINUE
270   CONTINUE
      PRINT*," "
      GO TO 291
```

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280   PRINT*,"     THE VALUES FOR EFFLUENT DISCHARGE FOR TIME PERIOD"
      PRINT*,"            ",ITP," ARE LISTED BY EFFLUENT BELOW.  TO"
      PRINT*,"            CHANGE A VALUE RESPOND TO THE TRAILING '?' BY"
      PRINT*,"            THE NEW VALUE."
      DO 290 IIE=1,NIE
      PRINT*,"                  ",IIE,")  ",EQ(IIE),
      READ(1,*) EQ(IIE)
      IF(EOF(1)) 289,290
289   CONTINUE
290   CONTINUE
291   PRINT*," "
      PRINT*,"     REVIEW ANOTHER EFFLUENT ATTRIBUTE (ANS: YES OR NO)",
      READ(1,901) IANS4
      IF(EOF(1)) 291,292
292   IF(IANS4.NE."N".AND.IANS4.NE."Y") GO TO 291
      IF(IANS4.EQ."N") GO TO 500
293   PRINT*,"     WHICH ATTRIBUTE",
      READ(1,*) IWQC
      IF(EOF(1)) 293,294
294   IF(IWQC.LT.1.OR.IWQC.GT.NTWQC+1) GO TO 259
      GO TO 262
300   PRINT*," "
      PRINT*,"     INDICATE THE INDEX NUMBER OF THE KINETIC PARAMETER"
      PRINT*,"            YOU ARE INTERESTED IN REVIEWING"
309   DO 310 IK=1,NK
310   PRINT*,"                  ",IK,")  ",KNAME(IK)
311   PRINT*,"          ",
      READ(1,*) IK
      IF(EOF(1)) 311,312
312   IF(IK.LT.1.OR.IK.GT.NK) GO TO 311
      PRINT*," "
313   PRINT*,"     THE VALUES CURRENTLY SPECIFIED FOR ",KNAME(IK),"WILL"
      PRINT*,"            BE LISTED BELOW BY REACH.  TO CHANGE A VALUE"
      PRINT*,"            RESPOND TO THE TRAILING '?' WITH THE NEW"
      PRINT*,"            VALUE."
      DO 320 IR=1,NR
      PRINT*,"                  ",IR,")  ",K20(IR,IK),
      READ(1,*) K20(IR,IK)
      IF(EOF(1)) 319,320
319   CONTINUE
320   CONTINUE
321   PRINT*,"     REVIEW ANOTHER RATE COEFFICIENT (ANS: YES OR NO)",
      READ(1,901) IANS5
      IF(EOF(1)) 321,322
322   IF(IANS5.NE."Y".AND.IANS5.NE."N") GO TO 321
      IF(IANS5.EQ."N") GO TO 500
330   PRINT*,"     WHICH ONE",
      READ(1,*) IK
      IF(EOF(1)) 330,331
331   IF(IK.LT.1.OR.IK.GT.NK) GO TO 309
      GO TO 313
350   PRINT*," "
      PRINT*,"     INDICATE THE INDEX NUMBER OF THE DISTRIBUTED"
      PRINT*,"            SOURCE/SINK TERM YOU WISH TO REVIEW"
359   DO 360 IS=1,NS
360   PRINT*,"                  ",IS,")  ",SNAME(IS)
361   PRINT*,"          ",
      READ(1,*) IS
      IF(EOF(1)) 361,362
362   IF(IS.LT.0.OR.IS.GT.NS) GO TO 361
363   PRINT*," "
      PRINT*,"     THE VALUES CURRENTLY SPECIFIED FOR ",SNAME(IS),"WILL"
      PRINT*,"            BE LISTED BELOW BY REACH.  TO CHANGE A VALUE"
      PRINT*,"            RESPOND TO THE TRAILING '?' WITH THE NEW"
      PRINT*,"            VALUE."
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      DO 370 IR=1,NR
      PRINT*,"                    ",IR,")   ",S20(IR,IS),
      READ(1,*) S20(IR,IS)
      IF(EOF(1)) 369,370
369   CONTINUE
370   CONTINUE
371   PRINT*,"      REVIEW ANOTHER SOURCE/SINK TERM (ANS: YES OR NO)",
      READ(1,901) IANS6
      IF(EOF(1)) 371,372
372   IF(IANS6.NE."N".AND.IANS6.NE."Y") GO TO 371
      IF(IANS6.EQ."N") GO TO 500
380   PRINT*,"      WHICH ONE",
      READ(1,*) IS
      IF(EOF(1)) 380,381
381   IF(IS.LT.1.OR.IS.GT.NS) GO TO 359
      GO TO 363
400   PRINT*," "
      PRINT*,"    THE CURRENT VALUES FOR MEAN ALGAL CONCENTRATIONS"
      PRINT*,"           ARE LISTED BELOW BY REACH AND FOR TIME PERIOD"
      PRINT*,"           ",ITP,".  TO CHANGE A VALUE RESPOND TO THE "
      PRINT*,"           TRAILING '?' BY THE NEW VALUE."
      DO 410 IR=1,NR
      PRINT*,"                    ",IR,")   ",A(IR),
      READ(1,*) A(IR)
      IF(EOF(1)) 409,410
409   CONTINUE
410   CONTINUE
      PRINT*," "
500   PRINT*," "
      PRINT*,"     CONTINUE FOR THIS TIME PERIOD (ANS: YES OR NO)",
501   READ(1,901) IANS1
      IF(EOF(1)) 501,502
502   IF(IANS1.NE."Y".AND.IANS1.NE."N") GO TO 501
      IF(IANS1.EQ."N") GO TO 510
      PRINT*," "
508   PRINT*,"     INDICATE PARAMETER TYPE ",
      READ*,IPARAM
      IF(EOF(1)) 508,509
509   IF(IPARAM.LT.0.OR.IPARAM.GT.6) GO TO 113
      GO TO (150,200,250,300,350,400),IPARAM
510   PRINT*," "
      PRINT*,"     REVIEW ANOTHER TIME PERIOD (ANS: YES OR NO)",
511   READ(1,901) IANS2
      IF(EOF(1)) 511,512
512   IF(IANS2.NE."Y".AND.IANS2.NE."N") GO TO 511
      CALL LOADVPS(ITP)
      IF(IANS2.EQ."Y") GO TO 100
      RETURN
      END
```

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C=======================================================================
      SUBROUTINE LOADTIP(ITP)
C=======================================================================
      COMMON/NAMES/TITLE(8),CNAME(20),SNAME(20),KNAME(20)
      COMMON/CNTRL/NR,NTP,NWQC,NB,NIT,NIE,IT(15),IE(15),HCODE,
     + MCODE(8),NCWQC,NNCWQC,NTWQC,NS,NK
      COMMON/IWQC/TWQ(15,20),EWQ(15,20),TQ(15),EQ(15)
      COMMON/KDATA/K20(20,20)
      COMMON/SDATA/S20(20,20)
      COMMON/MDATA/LR(20),DA(20),DEPTH(20),VEL(20),BCODE(15),
     + HAV(20),HBV(20),HAD(20),HBD(20)
      COMMON/BDATA/A(20)
      REAL LR,K20
      INTEGER TITLE,HCODE,CNAME
      INTEGER DINDEX(125),CNTRLS(8)
      DATA (CNAME(I),I=1,8)/"TEMP.","BOD5","TSS","NH3","NO2","NO3",
     + "PO4","D.O."/
C-----> LOAD DATA INTO MASS STORAGE FILE
      CALL WRITMS(9,TITLE,8,1,-1)
      CNTRLS(1)=NR
      CNTRLS(2)=NTP
      CNTRLS(3)=NCWQC
      CNTRLS(4)=NNCWQC
      CNTRLS(5)=HCODE
      CNTRLS(6)=NB
      CNTRLS(7)=NIT
      CNTRLS(8)=NIE
      CALL WRITMS(9,CNTRLS,8,2,-1)
      CALL WRITMS(9,MCODE,8,3,-1)
      NAATTS=NCWQC+NNCWQC
      IF(NAATTS.LE.0) GO TO 570
      CALL WRITMS(9,CNAME,NTWQC,4,-1)
570   CALL WRITMS(9,BCODE,NB,5,-1)
      CALL WRITMS(9,IT,NIT,6,-1)
      CALL WRITMS(9,IE,NIE,7,-1)
      CALL WRITMS(9,LR,NR,8,-1)
      CALL WRITMS(9,DA,NR,9,-1)
      IF(HCODE.EQ.0) GO TO 580
      CALL WRITMS(9,HAV,NR,10,-1)
      CALL WRITMS(9,HBV,NR,11,-1)
      CALL WRITMS(9,HAD,NR,12,-1)
      CALL WRITMS(9,HBD,NR,13,-1)
580   RETURN
      ENTRY LOADVPS
      NTWQC=8+NCWQC+NNCWQC
      NK=16+NNCWQC
      NS=NTWQC
      II=13+(ITP-1)*9
      IF(HCODE.EQ.1) GO TO 585
      INUM=II+1
      CALL WRITMS(9,VEL,NR,INUM,-1)
      INUM=II+2
      CALL WRITMS(9,DEPTH,NR,INUM,-1)
585   NUM=NIT*NTWQC
      INUM=II+3
      CALL WRITMS(9,TWQ,300,INUM,-1)
      INUM=II+4
      CALL WRITMS(9,TQ,NIT,INUM,-1)
      NUM=NIE*NTWQC
      INUM=II+5
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      CALL WRITMS(9,EWQ,300,INUM,-1)
      INUM=II+6
      CALL WRITMS(9,EQ,NIE,INUM,-1)
      NUM=NK*NR
      INUM=II+7
      CALL WRITMS(9,K20,400,INUM,-1)
      NUM=NS*NR
      INUM=II+8
      CALL WRITMS(9,S20,400,INUM,-1)
      INUM=II+9
      CALL WRITMS(9,A,NR,INUM,-1)
      RETURN
      END
C======================================================================
      SUBROUTINE UNLOAD(ITP)
C======================================================================
      COMMON/NAMES/TITLE(8),CNAME(20),SNAME(20),KNAME(20)
      COMMON/CNTRL/NR,NTP,NWQC,NB,NIT,NIE,IT(15),IE(15),HCODE,
     + MCODE(8),NCWQC,NNCWQC,NTWQC,NS,NK
      COMMON/IWQC/TWQ(15,20),EWQ(15,20),TQ(15),EQ(15)
      COMMON/KDATA/K20(20,20)
      COMMON/SDATA/S20(20,20)
      COMMON/MDATA/LR(20),DA(20),DEPTH(20),VEL(20),BCODE(15),
     + HAV(20),HBV(20),HAD(20),HBD(20)
      COMMON/BDATA/A(20)
      REAL LR,K20
      INTEGER TITLE,HCODE,CNAME
      INTEGER DINDEX(125),CNTRLS(8)
C-----> UNLOAD DATA FROM MASS STORAGE FILE
      CALL READMS(9,TITLE,8,1)
      CALL READMS(9,CNTRLS,8,2)
      NR=CNTRLS(1)
      NTP=CNTRLS(2)
      NCWQC=CNTRLS(3)
      NNCWQC=CNTRLS(4)
      HCODE=CNTRLS(5)
      NB=CNTRLS(6)
      NIT=CNTRLS(7)
      NIE=CNTRLS(8)
      NWQC=8
      NK=16+NNCWQC
      NS=8+NNCWQC+NCWQC
      NTWQC=8+NCWQC+NNCWQC
      CALL READMS(9,MCODE,8,3)
      NAATTS=NCWQC+NNCWQC
      IF(NAATTS.LE.0) GO TO 570
      CALL READMS(9,CNAME,NTWQC,4)
570   CALL READMS(9,BCODE,NB,5)
      CALL READMS(9,IT,NIT,6)
      CALL READMS(9,IE,NIE,7)
      CALL READMS(9,LR,NR,8)
      CALL READMS(9,DA,NR,9)
      IF(HCODE.EQ.0) GO TO 580
      CALL READMS(9,HAV,NR,10)
      CALL READMS(9,HBV,NR,11)
      CALL READMS(9,HAD,NR,12)
      CALL READMS(9,HBD,NR,13)
580   RETURN
```

```
      ENTRY UNLTVPS
      II=13+(ITP-1)*9
      IF(HCODE.EQ.1) GO TO 585
      INUM=II+1
      CALL READMS(9,VEL,NR,INUM)
      INUM=II+2
      CALL READMS(9,DEPTH,NR,INUM)
585   NUM=NIT*NTWQC
      INUM=II+3
      CALL READMS(9,TWQ,300,INUM)
      INUM=II+4
      CALL READMS(9,TQ,NIT,INUM)
      NUM=NIE*NTWQC
      INUM=II+5
      CALL READMS(9,EWQ,300,INUM)
      INUM=II+6
      CALL READMS(9,EQ,NIE,INUM)
      NUM=NK*NR
      INUM=II+7
      CALL READMS(9,K20,400,INUM)
      NUM=NS*NR
      INUM=II+8
      CALL READMS(9,S20,400,INUM)
      INUM=II+9
      CALL READMS(9,A,NR,INUM)
      RETURN
      END
C======================================================================
      SUBROUTINE WAIT
C======================================================================
      READ*,DUMMY
      IF(EOF(1))1,2
1     GO TO 2
2     DO 3 I=1,5
3     PRINT*," "
      RETURN
      END
```

SOURCE LISTING OF SIMWQ

```
      PROGRAM WQMAIN(OUTPUT,TAPE4=OUTPUT,TAPE9,TAPE33)
      COMMON/NAMES/TITLE(8),CNAME(20)
      COMMON/CNTRL/NR,NTP,NWQC,NB,NIT,NIE,IT(15),IE(15),HCODE,
     + MCODE(8),IR,IB,IPP,NCWQC,NNCWQC,NTWQC,NPP
      COMMON/IWQC/TWQ(15,20),EWQ(15,20),TQ(15),EQ(15),
     + BWQ(5,20),BQ(5)
      COMMON/KDATA/K20(20,20),KT(20)/QDATA/Q10K(20),Q10S(20)
      COMMON/SDATA/S20(20,20),ST(20)
      COMMON/MDATA/LR(20),DA(20),DEPTH(20),VEL(20),BCODE(5),
     + HAV(20),HBV(20),HAD(20),HBD(20)
      COMMON/BDATA/PN,PP,A(20)
      COMMON/APARAM/ALPHA(20),BETA(20,5),GAMMA(20,5),DELTA(20),
     + EPSIL(20,5),ZETA(20)
      DIMENSION WQ(200,20),Q(200),X(200,3)
      REAL K20,KT,LR
      INTEGER TITLE,HCODE,CNAME,DINDEX(125)
      DATA Q10K/20*1.0/,Q10S/20*1.0/,PP/0.05/,PN/0.10/
      DATA (CNAME(I),I=1,8)/"TEMP.","TSS","BOD","NH3","NO2","NO3",
     + "PO4","D.O."/
C
C-----> INPUT DATA FROM 'TAPE9'
C
      CALL OPENMS(9,DINDEX,125,0)
      CALL LOADDAT(ITP)
C
C-----> BEGIN SIMULATIONS FOR DISCRETE TIME PERIODS
C
      DO 100 ITP=1,NTP
C
      CALL LOADTVP(ITP)
C
C----------> WATER QUALITY SIMULATIONS
C
      CALL SIMWQ(WQ,Q,X)
C
C-----> OUTPUT RESULTS TO 'WQFLS'
C
      CALL WQOUTMS(WQ,Q,X,ITP)
100   CONTINUE
C
      PRINT*,"=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+="
      PRINT*," "
      PRINT*,"     SIMULATED WATER QUALITY PROFILES HAVE BEEN"
      PRINT*,"          OUTPUT TO 'TAPE33' FOR ",ITP-1," TIME"
      PRINT*,"          PERIOD(S) FOR THE FOLLOWING WATER"
      PRINT*,"          QUALITY ATTRIBUTES:"
      PRINT*," "
      DO 200 IATT=1,NTWQC
200   PRINT*,"     ",IATT,")  ",CNAME(IATT)
      PRINT*," "
      PRINT*,"=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+="
      CALL CLOSMS(9)
      STOP
```

INDEX FOR ALL VARIABLES AND PARAMETERS USED IN 'SIMWQ'

A(IR)	ALGAL CONCENTRATIONS IN REACH 'IR' (MG/L)
ALPHA(IC)	PARAMETER FOR ANALYTICAL WQ SOLUTION (MG/L)
ATT	KEY FOR MASS STORAGE OF WQ VECTOR
BCODE(IB)	BIFURACTION CODE DEFINING WATERSHED BRANCHES
BETA(IC,I)	PARAMETER FOR ANALYTICAL WQ SOLUTION (MG/L)
BQ(IB)	DISCHARGE AT MINOR TRIBUTARY AT IB'TH BIFURCATION (FT**3/SEC)
BWQ(IB,IC)	WQ VECTOR AT MINOR TRIBUTARY AT IB'TH BIFURCATION
CNAME(IC)	ALPHABETIC NAMES OF WATER QUALITY ATTIBUTES
CNTRLS(8)	ARRAY HOLDING SIMULATION CONTROL PARAMETERS FOR TRANSFER TO AND FROM MASS STORAGE (NR,NTP,NTWQC,ETC.)
DA(IR)	DRAINAGE AREA UPSTREAM FROM IR'TH REACH (MILES**2)
DELTA(IC,I)	PARAMETER FOR ANALYTICAL WQ SOLUTION
DEPTH(IR)	MEAN DEPTH OF IR'TH REACH (FEET)
DINDEX(I)	MASTER INDEX FOR MASS STORAGE OF SIMULATION DATA
EPSIL(IC,I)	PARAMETER FOR ANALYTICAL WQ SOLUTION
EQ(IE)	DISCHARGE AT IE'TH POINT SOURCE EFFLUENT INPUT (FT*3/SEC)
EWQ(IE,IC)	WATER QUALITY VECTOR AT IE'TH EFFLUENT INPUT
GAMMA(IC,I)	PARAMETER FOR ANALYTICAL WQ SOLTIONS
HAD(IR)	HYDRAULIC RATING PARAMETER FOR MEAN DEPTHS
HAV(IR)	HYDRAULIC RATING PARAMETER FOR MEAN VELOCITIES
HBD(IR)	HYDRAULIC RATING PARAMETER FOR MEAN DEPTHS
HBV(IR)	HYDRAULIC RATING PARAMETER FOR MEAN VELOCITIES
HCODE	SWITCH FOR SPECIFYING MODELING CHOICE FOR DEPTH VEL
IATT	ATTRIBUTE INDEX (1 TO 20)
IB	BIFURACTION INDEX (1 TO 5)
IC	WQ CONSTITUENT INDEX (1 TO 20); SAME AS IATT
IE(IIE)	EFFLUENT INPUT INDEX (1 TO 15)
INUM	INDEX FOR SPECIFICATION OF RECORD KEY FOR MASS STORAGE OF WQ VECTORS
IP	SAME AS IPP
IPP	INDEX OF PROFILE POINT IN SIMULATION RESULTS (1 TO 200)
IR	INDEX OF REACH (1 TO 20)
IREC	RECORD KEY INDEX FOR MASS STORAGE OUTPUT OF WQ VECTOR
IRECIP	INDEX OF RECIEVING REACH (DOWNSTREAM) OF IB'TH BIFUCATION
IT(IIT)	INDEX OF INPUT LOCATION OF TRIBUTARIES
ITOP	INDEX SPECIFYING TOP OF SUPERIOR CHANNEL BRANCHES
ITP	INDEX OF TIME PERIOD (1 TO 12)
IWQC	INDEX OF WATER QUALITY CONSTITUENTS (1 TO 20)
KT	TEMPERATURE ADJUSTED KINETIC RATE COEFFICIENT (1/DAY)
K20	KINETIC RATE COEFFICIENT AT 20 DEGREES C (1/DAY)
LR(IR)	LENGTH OF IR'TH REACH (MILES)
MCODE(IC)	MODELING CODE FOR IC'TH ATTRIBUTE
NAATTS	NUMBER OF WQ ATTRIBUTES
NB	NUMBER OF BIFURCATIONS OF STREAM CHANNEL (0<NB<5)
NCWQC	NUMBER OF CONSERVATION WQ CONSITUENTS (0<NCWQC<12-NNCWQC)
NIE	NUMBER OF POINT SOURCE EFFLUENT INPUTS (0<NIE<15)
NIT	NUMBER OF TRIBUTARY INPUTS (1<NIT<15)
NK	NUMBER OF RATE COEFFICIENTS NECESSARY FOR SIMULATION
NNCWQC	NUMBER OF NON-CONSERVATION WQ CONSTITUENTS
NPP	NUMBER OF PROFILE POINTS IN SIMULATION OF CURRENT
NR	NUMBER OF REACHES IN CURRENT SIMULATION (1<NR<20)
NS	NUMBER OF SOURCE/SINK TERMS IN SIMULATION (0<NS<20)
NTP	NUMBER OF TIME PERIODS IN SIMULATION RUN (1<NTP<12)
NTWQC	NUMBER OF TOTAL WQ CONSTITUENTS IN SIMULATION (NTWQC<20)
NWQC	NUMBER OF CORE WATER QUALTIY CONSTITUENTS IN SIMULATION
PN	PERCENT OF NITROGEN IN SUSPENDED SOLIDS ($/100)
PP	PERCENT OF PHOSPHORUS IN SUSPSENDED SOLIDS ($/100)

```
*   Q(IPP)        STREAM DISCHARGE AT IPP'TH POINT OF OUTPUT PROFILE (FT**3/SEC*
*   QB            DISCHARGE INPUT FROM BIFURCATION TO CURRENT REACH (CFS)       *
*   QE            DISCHARGE INPUT FROM TRIBUTARIES TO CURRENT REACH (CFS)       *
*   QINDEX(I)     MASTER INDEX FOR MASS STORAGE OF SIMULATED WQ PROFILES        *
*   QT            DISCHARGE INPUT FROM TRIBUTARIES TO CURRENT REACH (CFS)       *
*   QO            DISCHARGE AT TOP OF CURRENT REACH AFTER DILUTIONS (CFS)       *
*   Q10K(IK)      TEMPERATURE CORRECTION FACTOR FOR IK'TH RATE COEFFICIENT      *
*   Q10S(IS)      TEMPERATURE CORRECTION FACTOR FOR IS'TH SOURCE/SINK TERM      *
*   ST(IR,IS)     TEMPERATURE CORRECTED SOURCE/SINK TERM FOR IR'TH REACH        *
*   S20(IR,IS)    SOURCE/SINK TERM AT 20 DEGREES C (MG/L/DAY)                   *
*   TEMP          WATER TEMPERATURE (DEGREES C)                                 *
*   TITLE(8)      SIMULATION NAME                                               *
*   TLR           TOTAL LENGTH OF STREAM TO BE SIMULATED (MILES)                *
*   TQ(IT)        DISCHARGE IN IT'TH TRIBUTARY (CFS)                            *
*   TTWR          TOTAL TIME OF TRAVEL WITHIN CURRENT REACH (DAYS)              *
*   TWQ(IT,IC)    WATER QUALITY VECTOR FOR IT'TH TRIBUTARY INPUT                *
*   VEL(IR)       MEAN VELOCITY IN IR'TH REACH (MILES/DAY)                      *
*   WQ(IPP)       WATER QUALITY VECTOR AT IPP'TH POINT IN SIMULATION            *
*   WQB(IB,IC)    WATER QUALITY VECTOR FOR IB'TH BIFURCATION INPUT              *
*   WQE(IE,IC)    WATER QUALITY VECTOR FOR IE'TH EFFLUENT INPUT                 *
*   WQT(IT,IC)    WATER QUALITY VECTOR FOR IT'TH TRIBUTARY INPUT                *
*   WQO(IC)       WATER QUALITY VECTOR AT TOP OF CURRENT REACH AFTER            *
*   X(IPP,3)      DISTANCE ARRAY SPECIFING DISTANCE DOWNSTREAM, REACH           *
*   XIB           INDEX OF LOCATION ON WATERSHED BRANCHES                       *
*   XINC          INCREMENT BETWEEN PROFILE POINTS IN SIMULATION OUTPUT         *
*   XIR           INDEX OF LOCATION IN TERMS OF STREAM REACH                    *
*   XLAST         DISTANCE AT TOP OF CURRENT REACH                              *
*   XWR           DISTANCE FROM TOP OF CURRENT REACH                            *
*   ZETA          PARAMETER FOR ANALYTICAL WQ SOLUTION                          *
*                                                                               *
      END                                                                       *
*********************************************************************************
C===========================================================================
      SUBROUTINE ASOLN(TTWR,WQ)
C===========================================================================
      COMMON/CNTRL/NR,NTP,NWQC,NB,NIT,NIE,IT(15),IE(15),HCODE,
     + MCODE(8),IR,IB,IPP,NCWQC,NNCWQC,NTWQC,NPP
      COMMON/APARAM/ALPHA(20),BETA(20,5),GAMMA(20,5),DELTA(20),
     + EPSIL(20,5),ZETA(20)
      DIMENSION NE(20),WQ(200,20)
      DATA (NE(I),I=1,20)/3*1,2,2*3,2,5,12*1/
      DOSAT(TEMP)=14.652-0.41022*TEMP+0.007991*TEMP**2
     + -0.00007774*TEMP**3
C
C----- DOWNSTREAM PROFILE CALCULATION OF WATER QUALITY
C
      DO 899 J=1,NTWQC
      WQ(IPP,J)=ALPHA(J)+DELTA(J)*TTWR+ZETA(J)*TTWR**2
           II=NE(J)
           DO 799 K=1,II
           WQ(IPP,J)=WQ(IPP,J)+BETA(J,K)*EXP(-GAMMA(J,K)*TTWR)
           WQ(IPP,J)=WQ(IPP,J)+EPSIL(J,K)*TTWR*EXP(-GAMMA(J,K)*TTWR)
799   CONTINUE
899   CONTINUE
      WQ(IPP,8)=DOSAT(WQ(IPP,1))-WQ(IPP,8)
      RETURN
      END
```

```
C=====================================================================
      SUBROUTINE DILUTE(WQ,WQO,QO)
C=====================================================================
      COMMON/CNTRL/NR,NTP,NWQC,NB,NIT,NIE,IT(15),IE(15),HCODE,
     + MCODE(8),IR,IB,IPP,NCWQC,NNCWQC,NTWQC,NPP
      COMMON/IWQC/TWQ(15,20),EWQ(15,20),TQ(15),EQ(15),
     + BWQ(5,20),BQ(5)
      COMMON/MDATA/LR(20),DA(20),DEPTH(20),VEL(20),BCODE(5),
     + HAV(20),HBV(20),HAD(20),HBD(20)
      DIMENSION WQE(20),WQT(20),WQB(20),WQ(200,20),WQO(20),QO(20)
      REAL LR
C
C-----> ZERO TRIBUTARY AND EFFLUENT INPUTS
C
101   QT=0.0
      QE=0.0
      QB=0.0
      DO 102 I=1,NTWQC
      WQB(I)=0.0
      WQE(I)=0.0
102   WQT(I)=0.0
C
C-----> SELECT TRIBUTARY INPUTS FOR CURRENT REACH
C
      DO 110 I=1,NIT
      IF(IT(I).NE.IR) GO TO 110
      QT=TQ(I)
      DO 105 J=1,NTWQC
105   WQT(J)=TWQ(I,J)
      GO TO 111
110   CONTINUE
C
C-----> SELECT POINT SOURCE EFFLUENT INPUTS FOR CURRENT REACH
C
111   DO 120 I=1,NIE
      IF(IE(I).NE.IR) GO TO 120
      QE=EQ(I)
      DO 115 J=1,NTWQC
115   WQE(J)=EWQ(I,J)
      GO TO 121
120   CONTINUE
C
C-----> SELECT INPUTS FROM BIFURCATIONS
C
121   DO 130 I=1,NB
      IRECIP=INT(BCODE(I))
      IF(IRECIP.NE.IR) GO TO 130
      QB=BQ(I)
      DO 125 J=1,NTWQC
125   WQB(J)=BWQ(I,J)
      GO TO 131
130   CONTINUE
C
C-----> DILUTE WATER QUALITY VARIABLES
C
131   IF(IR.EQ.1) GO TO 140
      DO 135 I=1,NB
      ITOP=BCODE(I)*100.-INT(BCODE(I))*100+1
      IF(ITOP.EQ.IR) GO TO 140
135   CONTINUE
      QO(IR)=QE+QT+QB+QO(IR-1)
      GO TO 150
140   QO(IR)=QE+QT
      DO 145 K=1,NTWQC
145   WQO(K)=(QE*WQE(K)+QT*WQT(K))/QO(IR)
      GO TO 210
150   DO 200 K=1,NTWQC
200   WQO(K)=(QE*WQE(K)+QT*WQT(K)+QB*WQB(K)+QO(IR-1)*
     + WQ(IPP-1,K))/QO(IR)
210   CONTINUE
      RETURN
      END
```

```
C=======================================================================
      SUBROUTINE LOADDAT(ITP)
C=======================================================================
      REAL LR,K20
      COMMON/NAMES/TITLE(8),CNAME(20)
      COMMON/CNTRL/NR,NTP,NWQC,NB,NIT,NIE,IT(15),IE(15),HCODE,
     + MCODE(8),IR,IB,IPP,NCWQC,NNCWQC,NTWQC,NPP
      COMMON/IWQC/TWQ(15,20),EWQ(15,20),TQ(15),EQ(15),
     + BWQ(5,20),BQ(5)
      COMMON/KDATA/K20(20,20),KT(20)/QDATA/Q10K(20),Q103(20)
      COMMON/SDATA/S20(20,20),ST(20)
      COMMON/MDATA/LR(20),DA(20),DEPTH(20),VEL(20),BCODE(5),
     + HAV(20),HBV(20),HAD(20),HBD(20)
      COMMON/BDATA/PN,PP,A(20)
      INTEGER TITLE,HCODE,CNAME,DINDEX(125),CNTRLS(8)
C-----> UNLOAD DATA FROM MASS STORAGE FILE
      CALL READMS(9,TITLE,8,1)
      CALL READMS(9,CNTRLS,8,2)
      NR=CNTRLS(1)
      NTP=CNTRLS(2)
      NCWQC=CNTRLS(3)
      NNCWQC=CNTRLS(4)
      HCODE=CNTRLS(5)
      NB=CNTRLS(6)
      NIT=CNTRLS(7)
      NIE=CNTRLS(8)
      NWQC=8
      NK=16+NNCWQC
      NS=8+NNCWQC+NCWQC
      NTWQC=8+NCWQC+NNCWQC
      CALL READMS(9,MCODE,8,3)
      NAATTS=NCWQC+NNCWQC
      IF(NAATTS.LE.0) GO TO 570
      CALL READMS(9,CNAME,NTWQC,4)
570   CALL READMS(9,BCODE,NB,5)
      CALL READMS(9,IT,NIT,6)
      CALL READMS(9,IE,NIE,7)
      CALL READMS(9,LR,NR,8)
      CALL READMS(9,DA,NR,9)
      IF(HCODE.EQ.0) GO TO 580
      CALL READMS(9,HAV,NR,10)
      CALL READMS(9,HBV,NR,11)
      CALL READMS(9,HAD,NR,12)
      CALL READMS(9,HBD,NR,13)
580   RETURN
      ENTRY LOADTVP
      II=13+(ITP-1)*9
      IF(HCODE.EQ.1) GO TO 585
      INUM=II+1
      CALL READMS(9,VEL,NR,INUM)
      INUM=II+2
      CALL READMS(9,DEPTH,NR,INUM)
585   INUM=II+3
      CALL READMS(9,TWQ,300,INUM)
      INUM=II+4
      CALL READMS(9,TQ,NIT,INUM)
      INUM=II+5
      CALL READMS(9,EWQ,300,INUM)
      INUM=II+6
      CALL READMS(9,EQ,NIE,INUM)
      INUM=II+7
      CALL READMS(9,K20,400,INUM)
      INUM=II+8
      CALL READMS(9,S20,400,INUM)
      INUM=II+9
      CALL READMS(9,A,NR,INUM)
      CONTINUE
      RETURN
      END
```

```
C=====================================================================
      SUBROUTINE PCALC(WQ0)
C=====================================================================
      COMMON/APARAM/ALPHA(20),BETA(20,5),GAMMA(20,5),DELTA(20),
     + EPSIL(20,5),ZETA(20)
      COMMON/CNTRL/NR,NTP,NWQC,NB,NIT,NIE,IT(15),IE(15),HCODE,
     + MCODE(8),IR,IB,IPP,NCWQC,NNCWQC,NTWQC,NPP
      COMMON/KDATA/K20(20,20),KT(20)/QDATA/Q10K(20),Q10S(20)
      COMMON/SDATA/S20(20,20),ST(20)
      COMMON/BDATA/PN,PP,A(20)
      COMMON/MDATA/LR(20),DA(20),DEPTH(20),VEL(20),BCODE(5),
     + HAV(20),HBV(20),HAD(20),HBD(20)
      DIMENSION WQ0(20)
      REAL KT,K20,LR
      DATA (DELTA(I),I=1,20)/20*0.0/
      DATA ((EPSIL(I,J),I=1,20),J=1,5)/100*0.0/
      DATA (ZETA(I),I=1,20)/20*0.0/
      DOSAT(TEMP)=14.652-0.41022*TEMP+0.007991*TEMP**2
     + -0.00007774*TEMP**3
C
C---- TEMPERATURE PARAMETERS
C     -----------
100   GAMMA(1,1)=KT(15)
      IF(GAMMA(1,1).EQ.0.0) GO TO 150
      ALPHA(1)=ST(8)/GAMMA(1,1)
      BETA(1,1)=WQ0(1)-ALPHA(1)
      GO TO 200
150   DELTA(1)=ST(8)
      ALPHA(1)=WQ0(1)
      BETA(1,1)=0.0
C
C---- BOD PARAMETERS
C     ---
200   GAMMA(2,1)=KT(4)+KT(5)
      IF(GAMMA(2,1).EQ.0.0) GO TO 220
      ALPHA(2)=ST(1)/GAMMA(2,1)
      BETA(2,1)=WQ0(2)-ALPHA(2)
      GO TO 300
220   DELTA(2)=ST(1)
      ALPHA(2)=WQ0(2)
      BETA(2,1)=0.0
C
C---- TOTAL SUSPENDED SOLIDS PARAMETERS
C     ----- --------- ------
300   GAMMA(3,1)=KT(13)
      IF(DEPTH(IR).GT.0.0) GAMMA(3,1)=GAMMA(3,1)+KT(14)/DEPTH(IR)
      IF(GAMMA(3,1).EQ.0.0) GO TO 340
310   ALPHA(3)=ST(7)/GAMMA(3,1)
      BETA(3,1)=WQ0(3)-ALPHA(3)
      GO TO 400
340   DELTA(3)=ST(7)
      ALPHA(3)=WQ0(3)
      BETA(3,1)=0.0
C
C---- AMMONIA PARAMETERS
C     -------
400   GAMMA(4,1)=GAMMA(3,1)
      GAMMA(4,2)=KT(7)
      IF(GAMMA(4,1).EQ.0.0) GO TO 430
        (GAMMA(4,2).EQ.0.0) GO TO 460
      ALPHA(4)=(KT(6)*PN*ALPHA(3)+ST(2)-KT(1)*A(IR))/GAMMA(4,2)
      IF(GAMMA(4,1).EQ.GAMMA(4,2)) GO TO 410
      BETA(4,1)=(KT(6)*PN*BETA(4,1))/(GAMMA(4,2)-GAMMA(4,1))
      GO TO 490
410   BETA(4,1)=0.0
      EPSIL(4,1)=KT(6)*PN*ALPHA(3)
      GO TO 490
```

```
430   IF(GAMMA(4,1).EQ.GAMMA(4,2)) GO TO 480
      ALPHA(4)=(KT(6)*PN*ALPHA(3)+ST(2)-KT(1)*A(IR))/GAMMA(4,2)
      BETA(4,1)=0.0
      ZETA(4)=KT(6)*PN*ST(7)/2
      GO TO 490
460   BETA(4,1)=KT(6)*PN*ALPHA(3)/GAMMA(4,1)
      ALPHA(4)=0.0
      DELTA(4)=ST(2)-KT(1)*A(IR)+(KT(6)*PN*ST(7))/GAMMA(3,1)
      GO TO 500
480   DELTA(4)=ST(2)
      ALPHA(4)=WQO(4)
      BETA(4,1)=0.0
      BETA(4,2)=0.0
      GO TO 500
490   BETA(4,2)=WQO(4)-ALPHA(4)-BETA(4,1)
C
C---- NITRITE PARAMETERS
C     -------
500   GAMMA(5,1)=GAMMA(3,1)
      GAMMA(5,2)=GAMMA(4,2)
      GAMMA(5,3)=KT(8)
      IF(GAMMA(5,3).EQ.0.0) GAMMA(5,3)=.00001
      ALPHA(5)=GAMMA(4,2)*ALPHA(4)/GAMMA(5,3)
      IF(GAMMA(5,3).EQ.GAMMA(5,1)) GO TO 510
      BETA(5,1)=GAMMA(4,2)*BETA(4,1)/(GAMMA(5,3)-GAMMA(5,1))
502   IF(GAMMA(5,3).EQ.GAMMA(5,2)) GO TO 520
      BETA(5,2)=GAMMA(5,2)*BETA(4,2)/(GAMMA(5,3)-GAMMA(5,2))
506   BETA(5,3)=WQO(5)-ALPHA(5)-BETA(5,1)-BETA(5,2)
      GO TO 600
510   BETA(5,1)=0.0
      EPSIL(5,1)=GAMMA(4,2)*BETA(4,1)
      GO TO 502
520   BETA(5,2)=0.0
      EPSIL(5,2)=GAMMA(5,2)*BETA(4,2)
      GO TO 506
C
C---- NITRATE PARAMETERS
C     -------
600   GAMMA(6,1)=GAMMA(3,1)
      IF(GAMMA(6,1).EQ.0.0) GAMMA(6,1)=.00001
      GAMMA(6,2)=GAMMA(4,2)
      IF(GAMMA(6,2).EQ.0.0) GAMMA(6,2)=.00001
      GAMMA(6,3)=GAMMA(5,3)
      ALPHA(6)=WQO(6)
      BETA(6,1)=GAMMA(5,3)*BETA(5,1)/GAMMA(6,1)
      BETA(6,2)=GAMMA(5,3)*BETA(5,2)/GAMMA(6,2)
      BETA(6,3)=BETA(5,3)
      DELTA(6)=KT(8)*ALPHA(5)+ST(3)-KT(2)*A(IR)
C
C---- PHOSPHATE PARAMETERS
C     ---------
700   GAMMA(7,1)=GAMMA(3,1)
      GAMMA(7,2)=KT(11)
      IF(GAMMA(7,1).EQ.0.0) GO TO 730
      IF(GAMMA(7,2).EQ.0.0) GO TO 760
      ALPHA(7)=(KT(10)*PP*ALPHA(3)+ST(5)-KT(3)*A(IR))/KT(11)
      IF(GAMMA(7,1).EQ.GAMMA(7,2)) GO TO 710
      BETA(7,1)=(KT(10)*PP*BETA(3,1))/(GAMMA(7,2)-GAMMA(3,1))
      GO TO 790
710   BETA(7,1)=0.0
      EPSIL(7,1)=KT(10)*PP*ALPHA(3)
      GO TO 790
730   IF(GAMMA(7,1).EQ.GAMMA(7,2)) GO TO 730
      ALPHA(7)=(KT(10)*PP*ALPHA(3)+ST(5)-KT(3)*A(IR))/KT(11)
      BETA(7,1)=0.0
      ZETA(7)=KT(10)*PP*ST(7)/2
      GO TO 790
760   BETA(7,1)=KT(10)*PP*ALPHA(3)/GAMMA(7,1)
```

```
700     BETA(7,1)=KT(10)*PP*ALPHA(3)/GAMMA(7,1)
        ALPHA(7)=0.0
        DELTA(7)=ST(5)-KT(3)*A(IR)+(KT(10)*PP*ST(7))/GAMMA(3,1)
        GO TO 800
780     DELTA(7)=ST(7)
        ALPHA(7)=WQ0(7)
        BETA(7,1)=0.0
        BETA(7,2)=0.0
        GO TO 800
790     BETA(7,2)=WQ0(7)-ALPHA(7)-BETA(7,1)
C
C---- DISSOLVED OXYGEN PARAMETERS
C     --------- ------
800     GAMMA(8,1)=GAMMA(3,1)
        GAMMA(8,2)=GAMMA(5,3)
        GAMMA(8,3)=GAMMA(4,2)
        GAMMA(8,4)=GAMMA(2,1)
        GAMMA(8,5)=KT(12)
        ALPHA(8)=(KT(4)*ALPHA(2)+3.43*KT(7)*ALPHA(4)+1.14*KT(3)*ALPHA(5)-
       + ST(5)+ST(6))/KT(12)
        IF(GAMMA(8,5).EQ.GAMMA(3,1)) GO TO 810
        BETA(8,1)=(3.43*GAMMA(4,2)*BETA(4,1)+1.14*GAMMA(5,3)*BETA(5,1))/
       + (GAMMA(8,5)-GAMMA(3,1))
802     IF(GAMMA(8,5).EQ.GAMMA(5,3)) GO TO 820
        BETA(8,2)=(1.14*GAMMA(5,3)*BETA(5,3))/(GAMMA(8,5)-GAMMA(5,3))
804     IF(GAMMA(8,5).EQ.GAMMA(4,2)) GO TO 830
        BETA(8,3)=(3.43*GAMMA(4,2)*BETA(5,2))/(GAMMA(8,5)-GAMMA(4,2))
806     IF(GAMMA(8,5).EQ.GAMMA(2,1)) GO TO 840
        BETA(8,4)=(GAMMA(2,1)-KT(5))*BETA(2,1)/(GAMMA(8,5)-GAMMA(2,1))
808     BETA(8,5)=(DOSAT(WQ0(1))-WQ0(8))-ALPHA(8)-BETA(8,1)-BETA(8,2)
       + -BETA(8,3)-BETA(8,4)
        GO TO 900
810     BETA(8,1)=0.0
        EPSIL(8,1)=3.43*GAMMA(4,2)*BETA(4,1)+1.14*GAMMA(5,3)*BETA(5,1)
        GO TO 804
820     BETA(8,2)=0.0
        EPSIL(8,2)=1.14*GAMMA(5,3)*BETA(5,1)
        GO TO 806
830     BETA(8,3)=0.0
        EPSIL(8,3)=3.43*GAMMA(4,2)*BETA(4,1)
        GO TO 808
840     BETA(8,4)=0.0
        EPSIL(8,4)=GAMMA(2,1)-KT(5)*BETA(2,1)
        GO TO 808
C
C---- CONSERVATIVE WQ CONSTITUENTS
C     ------------
900     IF(NCWQC.LT.1) GO TO 950
        DO 930 I=1,NCWQC
        ALPHA(8+I)=WQ0(8+I)
        BETA(8+I,1)=0.0
        GAMMA(8+I,1)=0.0
930     DELTA(8+I)=ST(8+I)
C
C---- NONCONSERVATIVE WQ CONSTITUENTS
C     ---------------
950     IF(NNCWQC.LT.1) GO TO 999
        DO 970 I=1,NNCWQC
        GAMMA(8+NCWQC+I,1)=KT(8+NCWQC+I)
        IF(GAMMA(8+NCWQC+I,1).EQ.0.0) GO TO 960
        ALPHA(8+NCWQC+I)=ST(8+NCWQC+I)/GAMMA(8+NCWQC+I,1)
        BETA(8+NCWQC+I)=WQ0(8+NCWQC+I)-ALPHA(8+NCWQC+I)
        GO TO 970
960     DELTA(8+NCWQC+I)=ST(8+NCWQC+I)
        ALPHA(8+NCWQC+I)=WQ0(8+NCWQC+I)
        BETA(8+NCWQC+I,1)=0.0
970     CONTINUE
C
C
C
999     RETURN
        END
```

```
C=======================================================================
      SUBROUTINE RCALC(TEMP)
C=======================================================================
      COMMON/CNTRL/NR,NTP,NWQC,NB,NIT,NIE,IT(15),IE(15),HCODE,
     + MCODE(8),IR,IB,IPP,NCWQC,NNCWQC,NTWQC,NPP
      COMMON/KDATA/K20(20,20),KT(20)/QDATA/Q10K(20),Q10S(20)
      COMMON/SDATA/S20(20,20),ST(20)
      REAL K20,KT
C
C-----> Q10 CONVERSIONS OF RATE CONSTANTS
C
      NK=16+NNCWQC
      NS=8+NCWQC+NNCWQC
      DO 100 I=1,NK
100   KT(I)=K20(IR,I)*Q10K(I)**(TEMP-20)
      DO 200 I=1,NS
200   ST(I)=S20(IR,I)*Q10S(I)**(TEMP-20)
C
      RETURN
      END
C=======================================================================
      SUBROUTINE SIMWQ(WQ,Q,X)
C=======================================================================
      COMMON/CNTRL/NR,NTP,NWQC,NB,NIT,NIE,IT(15),IE(15),HCODE,
     + MCODE(8),IR,IB,IPP,NCWQC,NNCWQC,NTWQC,NPP
      COMMON/MDATA/LR(20),DA(20),DEPTH(20),VEL(20),BCODE(5),
     + HAV(20),HBV(20),HAD(20),HBD(20)
      COMMON/IWQC/TWQ(15,20),EWQ(15,20),TQ(15),EQ(15),
     + BWQ(5,20),BQ(5)
      DIMENSION WQ0(20),WQ(200,20),Q0(20),Q(200),X(200,3)
      REAL LR
      INTEGER HCODE
C
C-----> CALCULATE DISTANCE BETWEEN PROFILE POINTS FOR OUTPUT
C
      TLR=0.0
      DO 10 IR=1,NR
10    TLR=TLR+LR(IR)
      XINC=0.1
      DO 20 I=1,5
      NPP=TLR/XINC+2*NR
      IF(NPP.LE.200) GO TO 25
20    XINC=I*0.5
C
C-----> CALCULATE WATER QUALITY PROFILE FOR A FIXED TIME PERIOD
C
25    IPP=0
      XIB=NB
      XLAST=0.0
100   DO 500 IR=1,NR
      XIR=IR
      XWR=0.0
      IPP=IPP+1
C
      CALL DILUTE(WQ,WQ0,Q0)
C
      DO 110 IWQC=1,NTWQC
110   WQ(IPP,IWQC)=WQ0(IWQC)
      Q(IPP)=Q0(IR)
      X(IPP,1)=XLAST
      X(IPP,2)=XIR
      X(IPP,3)=XIB
C
      IF(HCODE.LT.1) GO TO 150
      VEL(IR)=HAV(IR)*Q0(IR)**HBV(IR)
      DEPTH(IR)=HAD(IR)*Q0(IR)**HBD(IR)
C
150   CALL RCALC(WQ0(1))
C
```

```
      CALL PCALC(WQ0)
C
200   IPP=IPP+1
      XWR=XWR+XINC
      IF(XWR.GE.LR(IR)) GO TO 300
      X(IPP,1)=XLAST+XWR
      X(IPP,2)=XIR
      X(IPP,3)=XIB
      Q(IPP)=Q0(IR)
      TTWR=XWR/VEL(IR)
C
      CALL ASOLN(TTWR,WQ)
C
      Q(IPP)=Q0(IR)
      GO TO 200
300   XWR=LR(IR)
      X(IPP,1)=XLAST+XWR
      X(IPP,2)=XIR
      X(IPP,3)=XIB
      Q(IPP)=Q0(IR)
      TTWR=XWR/VEL(IR)
C
      CALL ASOLN(TTWR,WQ)
C
      IF(NB.LT.1.OR.XIB.EQ.0.) GO TO 500
      DO 400 I=1,NB
      IEND=BCODE(I)*100.-INT(BCODE(I))*100.
      IF(IEND.NE.IR) GO TO 400
      XIB=XIB-1
      BQ(I)=Q(IPP)
      DO 350 IC=1,NTWQC
350   BWQ(I,IC)=WQ(IPP,IC)
400   CONTINUE
500   XLAST=X(IPP,1)
      NPP=IPP
      RETURN
      END
C=====================================================================
      SUBROUTINE WQOUTMS(WQ,Q,X,ITP)
C=====================================================================
      [illegible].ATT(200)
      COMMON/CNTRL/NR,NTP,NWQC,NB,NIT,NIS,IT(15),IE(15),HCODE,
     + MCODE(8),IR,IB,IPP,NCWQC,NNCWQC,NTWQC,NPP
      INTEGER CNAME,TITLE,HCODE
      IF(ITP.GT.1) GO TO 10
      CALL OPENMS(33,QINDEX,277,0)
10    IREC=23*(ITP-1)+1
      CALL WRITMS(33,NPP,1,IREC)
      IREC=23*(ITP-1)+2
      CALL WRITMS(33,X,600,IREC)
      IREC=23*(ITP-1)+3
      CALL WRITMS(33,Q,NPP,IREC)
      DO 30 IC=1,NTWQC
      DO 20 IP=1,NPP
20    ATT(IP)=WQ(IP,IC)
      IREC=23*(ITP-1)+IC+3
30    CALL WRITMS(33,ATT,NPP,IREC)
      IF(ITP.LT.NTP) GO TO 100
      CALL CLOSMS(33)
100   RETURN
      END
```

```
      PROGRAM WQTEST(INPUT,OUTPUT,TAPE3=INPUT,TAPE4=OUTPUT,
     + TAPE9,TAPE33)
      COMMON/NAMES/TITLE(8),CNAME(20)
      COMMON/CNTRL/NR,NTP,NWQC,NB,NIT,NIE,IT(15),IE(15),
     + MCODE(8),NCWQC,NNCWQC,NTWQC,NPP
      COMMON/MDATA/LR(20),DA(20),BCODE(15)
      DIMENSION X(200,3),WQ(240),PTS(2),XWQSV(20,12),UWQS(20,12),
     + LWQS(20,12),XX(240),IATTS(20)
      REAL LR,LWQS,LS
      INTEGER TITLE,CNAME
      DATA (CNAME(I),I=1,8)/"TEMP.","BOD5","TSS","NH3","NO2","NO3",
     + "PO4","D.O."/
      DATA XWQSV/240*0.0/,UWQS/240*9999./,LWQS/240*0.0/,IOPEN/0/
      PRINT*," "
      PRINT*," "
      PRINT*," "
      PRINT*," "
      PRINT*," "
      PRINT*,"+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+"
      PRINT*,"+  THIS RTV ROUTINE TESTS FOR VIOLATIONS OF AMBIENT   +"
      PRINT*,"+       WATER QUALITY STANDARDS AND QUANTIFIES THE     +"
      PRINT*,"+            SPACIAL EXTENT OF THESE VIOLATIONS         +"
      PRINT*,"+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+"
      PRINT*," "
C----->  READ DATA FROM 'TAPE9'
      CALL DATINMS
C----->  DESIGNATE ATTRIBUTES OF INTEREST
      PRINT*,"-------------------------------------------------------"
      PRINT*,"     ",(TITLE(I),I=1,8)
      PRINT*,"-------------------------------------------------------"
      PRINT*," "
      PRINT*,"     INDICATE WHICH WATER QUALITY ATTRIBUTE(S) ARE"
      PRINT*,"              TO BE ANALYZED."
      DO 40 I=1,4
40    PRINT*,"            ",I,")  ",CNAME(I),"      ",I+4,")  ",CNAME(I+4)
      IF(NTWQC.LE.8) GO TO 45
      DO 42 I=9,NTWQC
42    PRINT*,"                          ",I,")  ",CNAME(I)
      PRINT*,"     RESPOND WITH THE TOTAL NUMBER OF ATTRIBUTES "
      PRINT*,"          FOLLOWED BY THE APPROPRIATE INDEX NUMBERS"
45    PRINT*,"     ",
      READ(3,*) NATTS,(IATTS(I),I=1,NATTS)
      IF(EOF(3)) 999,46
46    IF(NATTS.GT.NTWQC) GO TO 45
      PRINT*," "
C----->  SPECIFY EXISTING WATER QUALITY STANDARDS
      PRINT*,"-------------------------------------------------------"
      PRINT*,"  INPUT LOCAL AMBIENT WATER QUALITY STANDARDS "
      PRINT*,"-------------------------------------------------------"
      PRINT*," "
      PRINT*," "
      ITP=1
52    PRINT*," "
      PRINT*,"     TIME PERIOD NO. ",ITP
      DO 59 IC=1,NATTS
      IWQC=IATTS(IC)
      PRINT*," "
      PRINT*,"     ",CNAME(IWQC)
      PRINT*,"     UPPER LEVEL STANDARD ",
      READ(3,*) UWQS(IWQC,ITP)
      IF(EOF(3))56,56
```

```
56     PRINT*,"     LOWER LEVEL STANDARD ",
       READ(3,*) LWQS(IWQC,ITP)
       IF(EOF(3)) 59,59
59     CONTINUE
       IF(ITP.EQ.1) GO TO 60
       ITP=ITP+1
       IF(ITP.GT.NTP) GO TO 69
       GO TO 52
60     PRINT*," "
       PRINT*,"     STANDARDS CONSTANT OVER TIME (Y OR N)",
       READ(3,940) IANS
       IF(EOF(3)) 60,61
61     IF(IANS.EQ."N") GO TO 52
       DO 68 ITP=2,NTP
       DO 66 IC=1,NATTS
       IWQC=IATTS(IC)
       UWQS(IWQC,ITP)=UWQS(IWQC,1)
66     LWQS(IWQC,ITP)=LWQS(IWQC,1)
68     CONTINUE
C-----> READ DATA FROM 'TAPE33'
69     DO 100 ITP=1,NTP
       DO 99 IC=1,NATTS
       IWQC=IATTS(IC)
       CALL INWQMS(IWQC,ITP,X,WQ,NPP)
       DO 90 IPP=1,NPP
       IF(IPP.EQ.1) GO TO 90
       IF(WQ(IPP).LT.UWQS(IWQC,ITP).AND.WQ(IPP).GT.LWQS(IWQC,ITP))
      + GO TO 90
       XWQSV(IC,ITP)=XWQSV(IC,ITP)+(X(IPP,1)-X(IPP-1,1))
90     CONTINUE
99     CONTINUE
100    CONTINUE
       PRINT*," "
       PRINT*," "
       PRINT*," "
       PRINT*,"======================================================"
       PRINT*,"   REPORT ON WATER QUALITY VIOLATIONS"
       PRINT*,"======================================================"
       PRINT*," "
       PRINT*," "
       PRINT*,"     1)  TOTAL RIVER MILES IN VIOLATION OF STANDARDS."
       PRINT*," "
       PRINT*,"                                      TIME PERIOD"
       PRINT*,"  ATTRIBUTE          1       2        3       4        5       6"
       PRINT*,"  ---------         ---     ---      ---     ---      ---     ---"
       DO 300 IC=1,NATTS
       IWQC=IATTS(IC)
       NEND=6
       IF(NTP.LT.6)NEND=NTP
       PRINT(4,930) CNAME(IWQC),(XWQSV(IC,J),J=1,NEND)
300    CONTINUE
       IF(NTP.LE.6) GO TO 399
       PRINT*," "
       CALL PAUSE
       PRINT*,"                                      TIME PERIOD"
       PRINT*,"  ATTRIBUTE          7       8        9       10       11      12"
       PRINT*,"  ---------         ---     ---      ---     ---      ---     ---"
       DO 310 IC=1,NATTS
       IWQC=IATTS(IC)
       PRINT(4,930) CNAME(IWQC),(XWQSV(IC,J),J=6,NTP)
310    CONTINUE
       PRINT*," "
       PRINT*," "
       PRINT*," "
       CALL PAUSE
```

```
C----->  ASK FOR GRAPHICAL OUTPUT
399   PRINT*," "
      PRINT*," "
      PRINT*," "
      PRINT*,"      DO YOU WANT A GRAPHICAL OUTPUT FOR ANY ATTRIBUTE"
400   PRINT*,"             PROFILES (ANS: YES OR NO)",
      READ(3,940) IANS
      IF(IANS.NE."Y".AND.IANS.NE."N") GO TO 400
      IF(IANS.EQ."N") GO TO 899
      CALL USTART
410   CALL UBELL
      PRINT*," "
      PRINT*,"      ATTRIBUTE NUMBER ",
      READ(3,*) IWQC
      IF(EOF(3)) 410,411
411   IF(IWQC.GT.NTWQC) GO TO 410
420   PRINT*," "
      PRINT*,"      TIME PERIOD ",
      READ(3,*) ITP
      IF(EOF(3)) 420,421
421   IF(ITP.GT.NTP) GO TO 420
      CALL INWQMS(IWQC,ITP,X,WQ,NPP)
      DO 430 IC=1,NATTS
      IF(IATTS(IC).NE.IWQC) GO TO 430
      US=UWQS(IWQC,ITP)
      LS=LWQS(IWQC,ITP)
      GO TO 431
430   CONTINUE
431   IF(US.LT.9999.) GO TO 460
      WQ(NPP+1)=LS
      WQ(NPP+2)=LS
      GO TO 470
460   WQ(NPP+1)=US
      WQ(NPP+2)=US
470   DO 479 I=1,NPP
479   XX(I)=X(I,1)
      XX(NPP+1)=0.0
      XX(NPP+2)=XX(NPP)
      PTS(1)=NPP
      PTS(2)=2
      PRINT(4,910) CNAME(IWQC),ITP
      CALL GOPLOT1(XX,WQ,PTS,IWQC)
      PRINT*," "
      PRINT*," "
      PRINT*," "
      PRINT*,"      PLOT ",CNAME(IWQC)," FOR ANOTHER TIME PERIOD ",
480   READ(3,940) IANS
      IF(EOF(3)) 480,481
481   IF(IANS.NE."Y".AND.IANS.NE."N") GO TO 480
      IF(IANS.EQ."Y") GO TO 420
      PRINT*,"      PLOT ANOTHER WATER QUALITY ATTRIBUTE ",
490   READ(3,940) IANS
      IF(EOF(3)) 490,491
491   IF(IANS.NE."Y".AND.IANS.NE."N") GO TO 490
      IF(IANS.EQ."Y") GO TO 410
      CALL UEND
940   FORMAT(1A1)
910   FORMAT(25X,1A5,":  TIME PERIOD NO. ",1I2)
930   FORMAT(4X,1A5,9X,6(1F5.1,2X))
899   PRINT*," "
      PRINT*," "
      PRINT*," "
      PRINT*," "
      PRINT*," "
999   PRINT*," "
      PRINT*,"======================================================="
      PRINT*,"      THIS CONCLUDES 'WQRTV'. YOU MAY EXECUTE MORE"
      PRINT*,"           RTV ROUTINES NOW, BEGIN A MITIGATION"
      PRINT*,"                       LOOP OR SIGNOFF."
      PRINT*,"======================================================="
      STOP
      END
```

```
      SUBROUTINE DATINMS
      COMMON/NAMES/TITLE(8),CNAME(20)
      COMMON/CNTRL/NR,NTP,NWQC,NB,NIT,NIE,IT(15),IE(15),
     + HCODE(8),NCWQC,NNCWQC,NTWQC,NPP
      COMMON/MDATA/LR(20),DA(20),BCODE(15)
      REAL LR
      INTEGER TITLE,HCODE,CNAME
      INTEGER DINDEX(125),CNTRLS(8)
C-----> UNLOAD DATA FROM MASS STORAGE FILE
      CALL OPENMS(9,DINDEX,125,0)
      CALL READMS(9,TITLE,8,1)
      CALL READMS(9,CNTRLS,8,2)
      NR=CNTRLS(1)
      NTP=CNTRLS(2)
      NCWQC=CNTRLS(3)
      NNCWQC=CNTRLS(4)
      HCODE=CNTRLS(5)
      NB=CNTRLS(6)
      NIT=CNTRLS(7)
      NIE=CNTRLS(8)
      NWQC=8
      NK=16+NNCWQC
      NS=8+NNCWQC+NCWQC
      NTWQC=8+NCWQC+NNCWQC
      NAATTS=NCWQC+NNCWQC
      IF(NAATTS.LE.0) GO TO 570
      CALL READMS(9,CNAME,NTWQC,4)
570   CALL READMS(9,BCODE,NB,5)
      CALL READMS(9,IT,NIT,6)
      CALL READMS(9,IE,NIE,7)
      CALL READMS(9,LR,NR,8)
      CALL READMS(9,DA,NR,9)
      RETURN
      END
      SUBROUTINE GOPLOT1(X,Y,PTS,IWQC)
      COMMON/NAMES/TITLE(8),CNAME(20)
      INTEGER TITLE,CNAME,OPTS(2)
      DIMENSION X(240),Y(240),PTS(2)
      DATA OPTS/"LO","DS"/
      CALL UDIMEN(7.,5.25)
      CALL USET("EDGEAXES")
      CALL UPSET("CHARACTER","+")
      CALL USET("XBOTH")
      CALL USET("YBOTH")
      CALL UPSET("XLABEL","DISTANCE DOWNSTREAM (MILES);")
      CALL UPSET("YLABEL","CONC. (MG/L);")
      CALL UBELL
      CALL UPLOT(X,Y,2.,PTS,OPTS)
      CALL UFLUSH
      CALL UPAUSE
      CALL UERASE
      RETURN
      END
      SUBROUTINE PAUSE
      PRINT*,"CONTINUE",
      READ(3,*) DUM
      IF(EOF(3))10,10
10    CONTINUE
      RETURN
      END
```

```
      SUBROUTINE INWQMS(IATT,ITP,X,ATT,NPP)
      DIMENSION WQ(200),X(200,3)
      INTEGER QINDEX(277)
      IF(IOPEN.GT.0) GO TO 10
      CALL OPENMS(33,QINDEX,277,0)
10    IREC1=23*(ITP-1)+1
      CALL READMS(33,NPP,1,IREC1)
      IREC2=23*(ITP-1)+2
      CALL READMS(33,X,600,IREC2)
      IREC3=23*(ITP-1)+3+IATT
      CALL READMS(33,ATT,NPP,IREC3)
      IOPEN=1
      RETURN
      END
/
```

```
type,ssirtv/g
```

```
      PROGRAM SIMAIN(INPUT,OUTPUT,TAPE1=INPUT,TAPE2=OUTPUT,TAPE9,
     + TAPE33)
      COMMON/NAMES/TITLE(8),CNAME(20)
      COMMON/CNTRL/NR,NTP,NWQC,NB,NIT,NIE,IT(15),IE(15),
     + MCODE(3),NCWQC,NNCWQC,NTWQC,NPP
      COMMON/MDATA/BCODE(15)
      DIMENSION X(200,3),BOD5(200),SI(200,12),XSI(10,12),SIT(7)
      INTEGER TITLE,CNAME,SNAME(7,2)
      DATA XSI/120*0.0/,SIT/-.5,1.5,2.5,3.5,4.5,5.5,6.5/
      DATA SNAME/"PUREST W","CLEAN WA","MILD POL","POLLUTED",
     + "HEAVILY ","RAW SEWA","SEPTIC C","ATER    ",
     + "TER     ","LUTION  ","        ","POLLUTED",
     + "GE      ","ONDITION"/
      CALL DATINMS
      DO 100 ITP=1,NTP
      CALL INWQMS(2,ITP,X,BOD5,NPP)
      DO 90 IPP=1,NPP
      IF(BOD5(ITP).GT.50.) GO TO 20
      SI(IPP,ITP)=(1.0747*BOD5(IPP)-0.4729)/(0.90408+0.218*BOD5(IPP))
      GO TO 21
20    SI(IPP,ITP)=(0.0189*BOD5(IPP)+7.938)/(1.882-0.0021*BOD5(IPP))
21    IF(IPP.EQ.1) GO TO 90
      DO 50 I=1,7
      IF(SI(IPP,ITP).GT.SIT(I)) GO TO 50
      XSI(I,ITP)=XSI(I,ITP)+X(IPP,1)-X(IPP-1,1)
      GO TO 90
50    CONTINUE
90    CONTINUE
100   CONTINUE
      PRINT*," "
      PRINT*,"      =================================================="
      PRINT*,"                     SAPROBIC INDEX ANALYSIS"
      PRINT*,"                               FOR"
      PRINT*,"                  ",(TITLE(I),I=1,4)
      PRINT*,"                  ",(TITLE(I),I=5,8)
      PRINT*,"      =================================================="
      PRINT*," "
      PRINT*," "
      NEND=6
      IF(NTP.LT.6)NEND=NTP
      PRINT*,"      WATER QUALITY           RIVER MILES IN TIME PERIOD"
      PRINT*,"       DESIGNATION        1      2      3      4      5      6"
      PRINT*,"      -------------     ----- ----- ----- ----- -----",
     + " -----"
      PRINT*," "
      DO 150 I=1,7
      PRINT(2,901) (SNAME(I,J),J=1,2),(XSI(I,ITP),ITP=1,NEND)
150   CONTINUE
      PRINT*,"      -------------     ----- ----- ----- ----- -----",
     + " -----"
      PRINT*," "
      IF(NTP.LE.6) GO TO 200
      NEND=12
      IF(NTP.LT.12)NEND=NTP
      NEND=6
      PRINT*,"      WATER QUALITY           RIVER MILES IN TIME PERIOD"
      PRINT*,"       DESIGNATION        7      8      9     10     11     12"
      PRINT*,"      -------------     ----- ----- ----- ----- -----",
     + " -----"
      PRINT*," "
      DO 160 I=1,7
      PRINT(2,901) (SNAME(I,J),J=1,2),(XSI(I,ITP) ITP=1,NEND)
160   CONTINUE
      PRINT*,"      -------------     ----- ----- ----- ----- -----",
     + " -----"
```

```
200    CONTINUE
       PRINT*," "
       PRINT*,"      DO YOU WANT FURTHER QUANTIFICATION OF THIS"
201    PRINT*,"            (ANS: YES OR NO)",
       READ(1,902) IANS
       IF(EOF(1)) 201,202
202    IF(IANS.NE."N".AND.IANS.NE."Y") GO TO 201
       IF(IANS.EQ."N") GO TO 300
       PRINT*," "
       PRINT*," "
       PRINT*,"      INPUT TIME PERIOD OF INTEREST ",
210    READ(1,*) ITP
       IF(EOF(1)) 210,211
211    IF(ITP.GT.NTP) GO TO 210
       PRINT*," "
       PRINT*,"      THIS SECTION ISN'T OPERATIONAL YET, BUT THE"
       PRINT*,"      OUTPUT WILL BE LOCATIONS OF ZONES IN EACH"
       PRINT*,"      WATER QUALITY DESIGNATION FOR THE SPECIFIED"
       PRINT*,"      TIME PERIOD."
300    CONTINUE
901    FORMAT(4X,2A8,3X,6(1X,1F5.1))
902    FORMAT(1A1)
       STOP
       END
C=====================================================================
       SUBROUTINE DATINMS
C=====================================================================
       COMMON/NAMES/TITLE(8),CNAME(20)
       COMMON/CNTRL/NR,NTP,NWQC,NB,NIT,NIE,IT(15),IE(15),
      + MCODE(8),NCWQC,NNCWQC,NTWQC,NPP
       COMMON/MDATA/LR(20),DA(20),BCODE(15)
       REAL LR
       INTEGER TITLE,HCODE,CNAME
       INTEGER DINDEX(125),CNTRLS(8)
C-----> UNLOAD DATA FROM MASS STORAGE FILE
       CALL OPENMS(9,DINDEX,125,0)
       CALL READMS(9,TITLE,8,1)
       CALL READMS(9,CNTRLS,8,2)
       NR=CNTRLS(1)
       NTP=CNTRLS(2)
       NCWQC=CNTRLS(3)
       NNCWQC=CNTRLS(4)
       HCODE=CNTRLS(5)
       NB=CNTRLS(6)
       NIT=CNTRLS(7)
       NIE=CNTRLS(8)
       NWQC=8
       NK=16+NNCWQC
       NS=8+NNCWQC+NCWQC
       NTWQC=8+NCWQC+NNCWQC
       NAATTS=NCWQC+NNCWQC
       IF(NAATTS.LE.0) GO TO 570
       CALL READMS(9,CNAME,NTWQC,4)
570    CALL READMS(9,BCODE,NB,5)
       CALL READMS(9,IT,NIT,6)
       CALL READMS(9,IE,NIE,7)
       RETURN
       END
```

```
C=========================================================================
      SUBROUTINE INWQMS(IATT,ITP,X,ATT,NPP)
C=========================================================================
      DIMENSION WQ(200),X(200,3)
      INTEGER QINDEX(277)
      IF(ITP.GT.1) GO TO 10
      CALL OPENMS(33,QINDEX,277,0)
10    IREC1=23*(ITP-1)+1
      CALL READMS(33,NPP,1,IREC1)
      IREC2=23*(ITP-1)+2
      CALL READMS(33,X,600,IREC2)
      IREC3=23*(ITP-1)+3+IATT
      CALL READMS(33,ATT,NPP,IREC3)
      RETURN
      END
```

```
      PROGRAM TUTEST(INPUT,OUTPUT,TAPE3=INPUT,TAPE4=OUTPUT,
     + TAPE9,TAPE33)
      COMMON/NAMES/TITLE(8),CNAME(20)
      COMMON/CNTRL/NR,NTP,NWQC,NB,NIT,NIE,
     + MCODE(8),NCWQC,NNCWQC,NTWQC,NPP
      COMMON/MDATA/LR(20),DA(20),BCODE(15)
      DIMENSION X(200,3),WQ(200),PTS(2),TU(10,5,200),MAXTU(10,5),
     + MEANTU(10,5),SPNAME(10,2),TNAME(10),XX(400),LC50(10,5),
     + ITOX(10),ISP(10),C(400),TOTTU(5,200),ISO(10)
      REAL LR,LC50,MAXTU,MEANTU,MAXTTU(5),MEANTTU(5)
      INTEGER TITLE,CNAME,TNAME,SPNAME
      DATA (CNAME(I),I=1,8)/"TEMP.","BOD5","TSS","NH3","NO2","NO3",
     + "PO4","D.O."/
      DATA (SPNAME(1,I),I=1,2)/"FATHEAD MI","NNOW       "/
      DATA (SPNAME(2,I),I=1,2)/"CARP      ","          "/
      DATA (SPNAME(3,I),I=1,2)/"BLUEGILL  ","          "/
      DATA (SPNAME(4,I),I=1,2)/"CHANNEL CA","T         "/
      DATA (SPNAME(5,I),I=1,2)/"LARGEMOUTH"," BASS     "/
      DATA (SPNAME(6,I),I=1,2)/"BROOK TROU","T         "/
      DATA (SPNAME(7,I),I=1,2)/"RAINBOW TR","OUT       "/
      DATA (SPNAME(8,I),I=1,2)/"COHO SALMO","N         "/
      DATA ISO/5*1,5*-1/
      DATA TOTTU/1000*0.0/
      PRINT*," "
      PRINT*," "
      PRINT*," "
      PRINT*," "
      PRINT*," "
      PRINT*,"+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+"
      PRINT*,"+      THIS RTV ROUTINE TESTS ENVIRONMENTAL TOXICITY     +"
      PRINT*,"+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+"
      PRINT*," "
C----->  READ DATA FROM 'TAPE9'
      CALL DATINMS
C----->  DESIGNATE ATTRIBUTES OF INTEREST
      PRINT*,"------------------------------------------------------------"
      PRINT*,"      ",(TITLE(I),I=1,8)
      PRINT*,"------------------------------------------------------------"
      PRINT*," "
      PRINT*,"      INDICATE WHICH WATER QUALITY ATTRIBUTE(S) ARE"
      PRINT*,"              TO BE ANALYZED FOR THEIR TOXIC EFFECTS."
      DO 10 I=1,4
10    PRINT*,"            ",I,")  ",CNAME(I),"      ",I+4,")  ",CNAME(I+4)
      IF(NTWQC.LE.8) GO TO 15
      DO 12 I=9,NTWQC
12    PRINT*,"                        ",I,")  ",CNAME(I)
      PRINT*,"      RESPOND WITH THE TOTAL NUMBER OF TOXICANTS "
      PRINT*,"           FOLLOWED BY THE APPROPRIATE INDEX NUMBERS"
15    PRINT*,"      ",
      READ(3,*) NTOX,(ITOX(I),I=1,NTOX)
      IF(EOF(3)) 999,16
16    IF(NTOX.GT.NTWQC) GO TO 15
      DO 18 I=1,NTOX
      IF(ITOX(I).LE.NTWQC) GO TO 18
      PRINT*,"      BAD INPUT; TRY AGAIN!"
      GO TO 15
18    TNAME(I)=CNAME(ITOX(I))
      PRINT*," "
20    PRINT*," "
```

```
      PRINT*,"     SPECIFY TARGET SPECIES:"
      PRINT*," "
21    PRINT*,"     DESIGNATE STREAM TYPE (W=WARM WATER,C=COLD WATER) ",
      READ(3,940) ISTRM
      IF(EOF(3)) 21,22
22    IF(ISTRM.NE."C".AND.ISTRM.NE."W") GO TO 21
C     SPECIFICATION OF TARGET SPECIES
      PRINT*," "
      PRINT*,"     REPRESENTATIVE SPECIES LIST:"
      DO 25 I=1,8
      IF(ISTRM.EQ."W".AND.ISO(I).LT.0.OR.
     + ISTRM.EQ."C".AND.ISO(I).GT.0) GO TO 25
      PRINT*,"          ",I,")   ",(SPNAME(I,J),J=1,2)
25    CONTINUE
      PRINT*,"     RESPOND WITH NUMBER OF TARGET SPECIES DESIRED AND"
      PRINT*,"          WITH THEIR APPROPRIATE INDEX NUMBER(S)."
26    PRINT*,"          ",
      READ(3,*) NSP,(ISP(I),I=1,NSP)
      IF(EOF(3)) 26,30
C     SPECIFY LC50'S FOR TARGET SPECIES
30    PRINT*," "
      PRINT*,"     INPUT THE 96 HOUR LC50'S FOR THE FOLLOWING SPECIES"
      PRINT*,"          AND POTENTIONAL TOXICANTS:"
      DO 35 IS=1,NSP
      PRINT*," "
      PRINT*,"     ",(SPNAME(ISP(IS),J),J=1,2)
      DO 33 IT=1,NTOX
32    PRINT*,"          ",TNAME(IT),
      READ(3,*) LC50(IT,IS)
      IF(EOF(3)) 32,33
33    CONTINUE
35    CONTINUE
      CALL USTART
      PRINT*," "
69    PRINT*,"     SPECIFY TIME PERIOD OF INTEREST ",
70    READ(3,*) ITP
      IF(EOF(3)) 70,71
71    IF(ITP.GT.NTP) GO TO 70
      PRINT*," "
      DO 99 IS=1,NSP
      DO 95 IT=1,NTOX
      SUMTU=0.0
      SUMTTU=0.0
      MAXTU(IT,IS)=0.
      IC=ITOX(IT)
      CALL INWQMS(IC,ITP,X,WQ,NPP)
      DO 90 IPP=1,NPP
      TU(IT,IS,IPP)=WQ(IPP)/LC50(IT,IS)
      IF(MAXTU(IT,IS).LT.TU(IT,IS,IPP))MAXTU(IT,IS)=TU(IT,IS,IPP)
      TOTTU(IS,IPP)=TOTTU(IS,IPP)+TU(IT,IS,IPP)
90    SUMTU=SUMTU+TU(IT,IS,IPP)
      MEANTU(IT,IS)=SUMTU/NPP
      MAXTTU(IS)=0.0
      DO 92 IPP=1,NPP
      IF(MAXTTU(IS).LT.TOTTU(IS,IPP)) MAXTTU(IS)=TOTTU(IS,IPP)
92    SUMTTU=SUMTTU+TOTTU(IS,IPP)
      MEANTTU(IS)=SUMTTU/NPP
95    CONTINUE
99    CONTINUE
      PRINT*," "
      PRINT*," "
      PRINT*," "
      PRINT*,"-----------------------------------------------------"
      PRINT*,"    REPORT ON TOXICITY IMPACTS IN TIME PERIOD ",ITP
      PRINT*,"-----------------------------------------------------"
```

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QUANTITATIVE ASSESSMENT OF ENVIRONMENTAL IMPACTS IN THE AQUATIC--ETC(U)
JAN 82   R RIGGINS, E HERRICKS, M J SALE   DACA88-78-R-006

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2 OF 2

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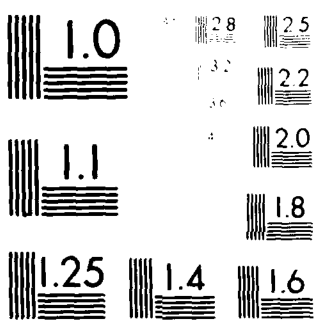

MICROCOPY RESOLUTION TEST CHART

```
      PRINT*," "
      PRINT*," "
      PRINT*,"     MAXIMUM AND MEAN (IN PARENTHESES) TOXICITY UNITS"
      PRINT*," "
      PRINT*,"                                        TOXICANT"
      NEND=5
      IF(NTOX.LT.5) NEND=NTOX
      PRINT(3,911) (TNAME(IT),IT=1,NEND)
      DO 300 IS=1,NSP
      PRINT(4,930) (SPNAME(ISP(IS),J),J=1,2),MAXTTU(IS),
     + (MAXTU(I,IS),I=1,NEND)
      PRINT(4,931) MEANTU(IS),(MEANTU(I,IS),I=1,NEND)
300   CONTINUE
      PRINT*," "
      PRINT*," "
      PRINT*," "
C----->  ASK FOR GRAPHICAL OUTPUT
399   PRINT*," "
      PRINT*," "
      PRINT*," "
      PRINT*,"     DO YOU WANT A GRAPHICAL OUTPUT FOR TOXICITY UNITS"
400   PRINT*,"          VS. LOCATION DOWNSTREAM (ANS: YES OR NO)",
      READ(3,940) IANS
      IF(IANS.NE."Y".AND.IANS.NE."N") GO TO 400
      IF(IANS.EQ."N") GO TO 899
410   CALL UBELL
      PRINT*," "
      PRINT*,"     INPUT TOXICANT NUMBER ",
      READ(3,*) IT
      IF(EOF(3)) 412,411
411   IF(IT.LE.NTOX) GO TO 420
412   DO 415 IT=1,NTOX
415   PRINT*,"     ",IT,")  ",TNAME(IT)
      PRINT*,"     ",
      READ(3,*) IT
      IF(EOF(3)) 412,411
420   PRINT*," "
      PRINT*,"     INPUT TARGET SPECIES INDEX ",
      READ(3,*) IS
      IF(EOF(3)) 422,421
421   IF(IS.LE.NSP) GO TO 449
422   DO 425 IS=1,NSP
425   PRINT*,"     ",IS,")  ",(SPNAME(ISP(IS),J),J=1,2)
      PRINT*,"     ",
      READ(3,*) IS
      IF(EOF(3)) 422,426
426   IF(IS.GT.NSP) GO TO 420
449   DO 450 IPP=1,NPP
      XX(IPP)=X(IPP,1)
      C(IPP)=TU(IT,IS,IPP)
      XX(IPP+NPP)=X(IPP,1)
450   C(IPP+NPP)=TOTTU(IS,IPP)
      PTS(1)=NPP
      PTS(2)=NPP
      PRINT*," "
      PRINT*," "
      PRINT*," "
      PRINT(4,910) (SPNAME(ISP(IS),J),J=1,2),TNAME(IT),ITP
      PRINT*,"          (T=TOTAL T.U.'S;  *=T.U.'S FROM SPECIFIED ATT.)"
      CALL GOPLOT1(XX,C,PTS)
      PRINT*," "
      PRINT*," "
      PRINT*," "
      PRINT*,"     PLOT TOXICITY IMPACTS FROM ",TNAME(IT)
      PRINT*,"          FOR ANOTHER TARGET SPECIES ",
```

```
480   READ(3,940) IANS
      IF(EOF(3)) 480,481
481   IF(IANS.NE."Y".AND.IANS.NE."N") GO TO 480
      IF(IANS.EQ."Y") GO TO 420
      PRINT*,"      PLOT FOR ANOTHER TOXICANT ",
490   READ(3,940) IANS
      IF(EOF(3)) 490,491
491   IF(IANS.NE."Y".AND.IANS.NE."N") GO TO 490
      IF(IANS.EQ."Y") GO TO 410
      PRINT*,"      DO YOU WISH TO CONTINUE ANALYSES FOR ANOTHER TIME"
      PRINT*,"            PERIOD (ANS: Y OR N)",
500   READ(3,940) IANS
      IF(EOF(3)) 500,501
501   IF(IANS.NE."Y".AND.IANS.NE."N") GO TO 500
      PRINT*," "
      IF(IANS.EQ."Y") GO TO 69
      CALL UEND
903   FORMAT(1I2)
910   FORMAT(15X,2A10," ; ",1A5," ; TIME PERIOD ",1I2)
911   FORMAT(3X,"TARGET SPECIES",8X,"TOTAL",3X,5(2X,1A5,2X),/,
     + 1X,20("-"),2X,6("--------",1X))
930   FORMAT(1X,2A10,1X,6(1X,1F7.3,1X))
931   FORMAT(22X,5(1X,"(",1F6.3,")"))
940   FORMAT(1A1)
899   PRINT*," "
      PRINT*," "
      PRINT*," "
      PRINT*," "
      PRINT*," "
999   PRINT*," "
      PRINT*,"======================================================"
      PRINT*,"      THIS CONCLUDES 'TURTV'. YOU MAY EXECUTE MORE"
      PRINT*,"           RTV ROUTINES NOW, BEGIN A MITIGATION"
      PRINT*,"                      LOOP OR SIGNOFF."
      PRINT*,"======================================================"
      STOP
      END
      SUBROUTINE DATINMS
      COMMON/NAMES/TITLE(8),CNAME(20)
      COMMON/CNTRL/NR,NTP,NWQC,NB,NIT,NIE,
     + HCODE(8),NCWQC,NNCWQC,NTWQC,NPP
      COMMON/MDATA/LR(20),DA(20),BCODE(15)
      REAL LR
      INTEGER TITLE,HCODE,CNAME
      INTEGER DINDEX(125),CNTRLS(8)
C-----> UNLOAD DATA FROM MASS STORAGE FILE
      CALL OPENMS(9,DINDEX,125,0)
      CALL READMS(9,TITLE,8,1)
      CALL READMS(9,CNTRLS,8,2)
      NR=CNTRLS(1)
      NTP=CNTRLS(2)
      NCWQC=CNTRLS(3)
      NNCWQC=CNTRLS(4)
      HCODE=CNTRLS(5)
      NB=CNTRLS(6)
      NIT=CNTRLS(7)
      NIE=CNTRLS(8)
      NWQC=8
      NK=16+NNCWQC
      NS=8+NNCWQC+NCWQC
      NTWQC=8+NCWQC+NNCWQC
      NAATTS=NCWQC+NNCWQC
      IF(NAATTS.LE.0) GO TO 570
      CALL READMS(9,CNAME,NTWQC,4)
570   CALL READMS(9,BCODE,NB,5)
      CALL READMS(9,IT,NIT,6)
      CALL READMS(9,IE,NIE,7)
```

```
      CALL READMS(9,LR,NR,8)
      CALL READMS(9,DA,NR,9)
      RETURN
      END
      SUBROUTINE GOPLOT1(X,Y,PTS)
      COMMON/NAMES/TITLE(8),CNAME(20)
      INTEGER TITLE,CNAME,OPTS(2)
      DIMENSION X(400),Y(400),PTS(2)
      DATA OPTS/"L*","LT"/
      CALL UDIMEN(7.5,5.20)
      CALL USET("EDGEAXES")
      CALL UPSET("CHARACTER",".")
      CALL USET("XBOTH")
      CALL USET("YBOTH")
      CALL UPSET("XLABEL","DISTANCE DOWNSTREAM (MILES);")
      CALL UPSET("YLABEL","TOX. UNITS;")
      CALL UBELL
      CALL UPLOT(X,Y,2.,PTS,OPTS)
      CALL UFLUSH
      CALL UPAUSE
      CALL UERASE
      RETURN
      END
      SUBROUTINE PAUSE
      PRINT*,"CONTINUE",
      READ(3,*) DUM
      IF(EOF(3))10,10
10    CONTINUE
      RETURN
      END
      SUBROUTINE INWQMS(IATT,ITP,X,ATT,NPP)
      DIMENSION WQ(200),X(200,3)
      INTEGER QINDEX(277)
      IF(IOPEN.GT.0) GO TO 10
      CALL OPENMS(33,QINDEX,277,0)
10    IREC1=23*(ITP-1)+1
      CALL READMS(33,NPP,1,IREC1)
      IREC2=23*(ITP-1)+2
      CALL READMS(33,X,600,IREC2)
      IREC3=23*(ITP-1)+3+IATT
      CALL READMS(33,ATT,NPP,IREC3)
      IOPEN=1
      RETURN
      END
/
```

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